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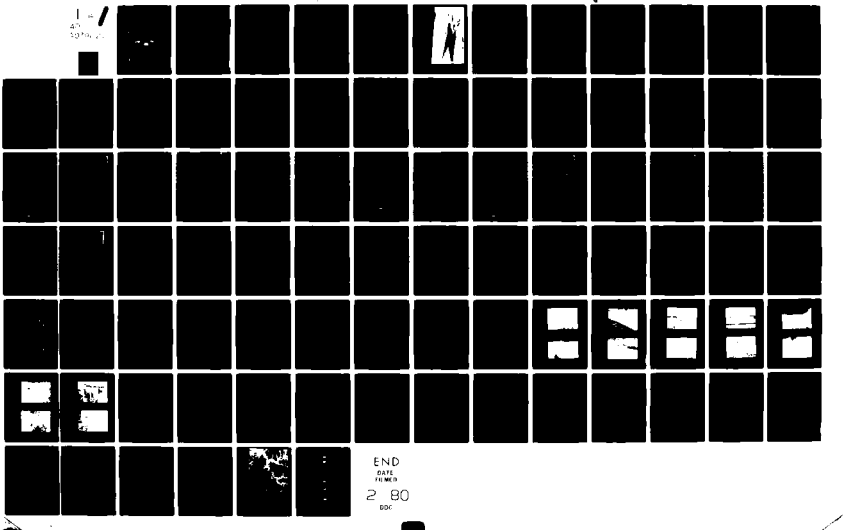

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OHIO RIVER BASIN

UNNAMED TRIBUTARY, SOUTH BRANCH OF BEAR CREEK, BUTLER COUNTY

PENNSYLVANIA

AD A079021

KOPPERS PETROLIA PLANT No. 3 RESERVOIR DAM

LEVEL II

NDI No. PA 00902

PennDER No. 10-74

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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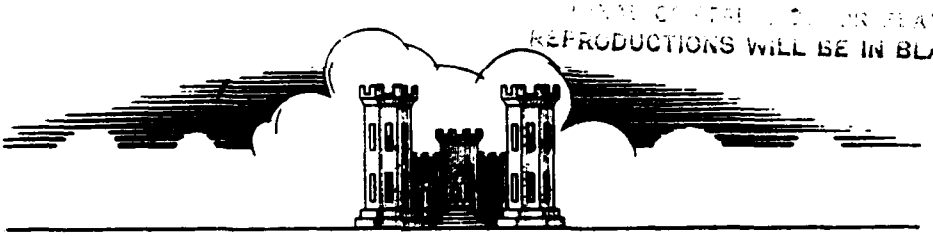

prepared for

DEPARTMENT OF THE ARMY

Baltimore District, Corps of Engineers

Baltimore, Maryland 21203

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prepared by

MICHAEL BAKER, JR., INC.

Consulting Engineers

4301 Dutch Ridge Road

Beaver, Pennsylvania 15009

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AUGUST 1979

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OHIO RIVER BASIN

KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
BUTLER COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI No. PA 00902
PennDER No. 10-74

(6) PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Koppers Petrolia Plant Number 3 Reservoir Dam (NDI #PA-00902) (Number) (PennDER #10-74) Ohio River Basin, Unamed Tributary South Branch of Beaver Creek, Butler County, Pennsylvania.

Prepared for: DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

Prepared by: MICHAEL BAKER, JR., INC.
Consulting Engineers
4301 Dutch Ridge Road
Beaver, Pennsylvania 15009

(11) Aug 79

(12) 87

(15) DACW31-79-C-0011

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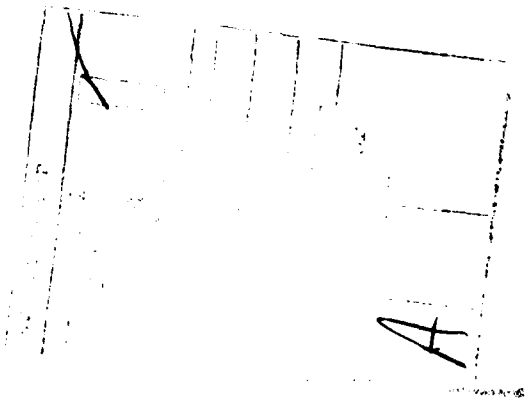
PREFACE

This report is prepared under guidance contained in the "Recommended Guidelines for Safety Inspection of Dams," for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.



PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Koppers Petrolia Plant - No. 3 Reservoir Dam
Butler County, Pennsylvania
NDI No. PA 00902, PennDER No. 10-74
Unnamed Tributary to the South Branch of Bear Creek
Inspected 17 May 1979

ASSESSMENT OF GENERAL CONDITIONS

Koppers Petrolia Plant - No. 3 Reservoir Dam is a zoned, earthfill dam owned and operated by the Koppers Company, Inc. The dam has a crest length of 710 feet, a maximum height of 59 feet, and a maximum storage capacity of 278 acre-feet. The dam is classified as a "High" hazard - "Intermediate" size dam.

Hydraulic/Hydrologic evaluations, performed in accordance with procedures established by the Baltimore District, Corps of Engineers, for Phase I Inspection Reports, revealed that the spillways will pass the Probable Maximum Flood (PMF) without overtopping the dam. The spillway is therefore considered "adequate."

The dam was found to be in fair overall condition at the time of inspection. Several items of remedial work should be performed by the owner without delay. These include:

1) The owner should engage the services of a qualified professional engineer to develop appropriate measures to control the seepage exiting at the right abutment junction to prevent erosion and undermining.

2) Repair the slide area on the right hillside to prevent blockage of the emergency spillway channel.

3) Provide riprap for the erosion ditch along the right hillside (running into the discharge channel).

4) Repair the toe drain outlet animal guards and repair the pipe where disjointed.

5) Replace the joint filler in the outlet conduit where necessary.

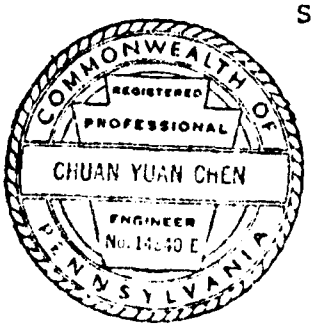
6) Restore the top of dam near the emergency spillway training wall to the original design elevation.

In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.



Submitted by:

MICHAEL BAKER, JR., INC.

C. Y. Chen

C. Y. Chen, Ph.D., P.E.
Engineering Manager-Geotechnical

Date: 24 August 1979

Approved by:

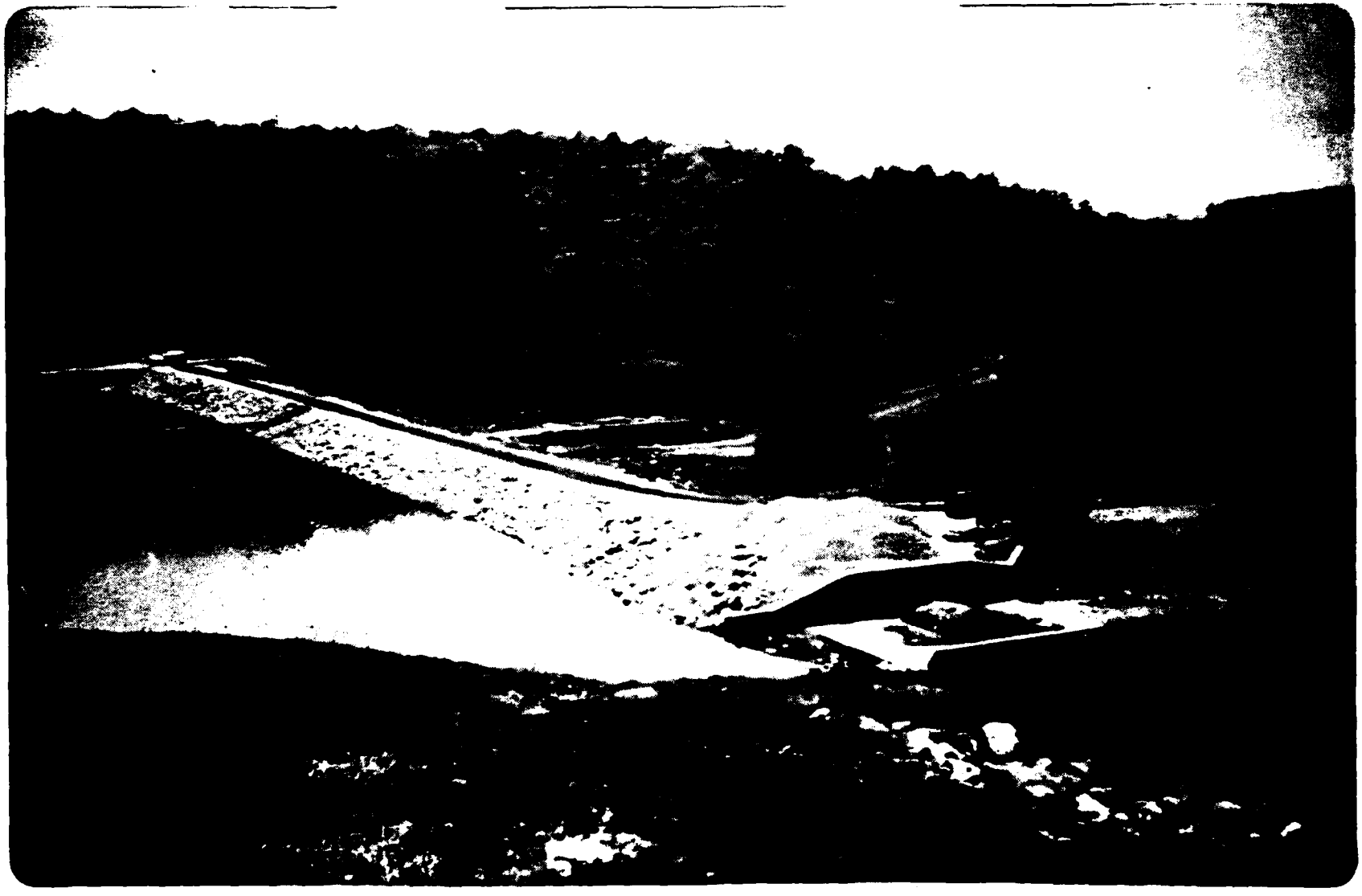
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 12 Sep 79

KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM



Overall View

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NATIONAL DAM INSPECTION PROGRAM
KOPPERS PETROLIA PLANT No. 3 RESERVOIR DAM
NDI No. PA 00902, PennDER No. 10-74

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority - The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose of Inspection - The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances - Koppers Petrolia Plant - No. 3 Reservoir Dam is a water supply dam owned and operated by the Koppers Company, Inc. The dam has also been referred to under such previous names as Koppers Dam, PA No Name No. 154, and Koppers Water Storage Impoundment. The dam is a zoned embankment with a maximum height of 59 feet and a crest length of 710 feet. The dam is constructed of a central impervious core and three increasing permeability zones toward the outer slopes. The drainage system consists of a rock-fill toe, toe drains, lateral drains, and the pervious outer zone of the embankment.

The outlet works (or principal spillway) consists of a two-way covered riser and a 48 inch outlet conduit. The length of each of the two weirs is 12 feet with a 2.5 foot vertical clearance. The 48 inch reinforced concrete pressure pipe is supported on a concrete cradle. Four intakes for water supply purposes extend upstream from the valve chamber on the riser. The three upper intakes (El. 1225, 1215, and 1205 feet) are 12 inch inner diameter cast-iron pipe. The lowest intake (El. 1195 feet) is a 24 inch inner diameter concrete pressure pipe.

The emergency spillway, located at the right abutment, consists of a rectangular reinforced concrete control channel and a 900 foot long trapezoidal earth and bedrock channel. At the end of the channel, when the emergency spillway is activated, the water will flow down a steep natural riprap covered slope to the South Branch of Bear Creek. The emergency spillway will be activated by a storm larger than the 100-year six hour recurrence interval storm. A 2.3 foot high fuse plug dike was designed to be eroded after the emergency spillway is activated.

b. Location - Koppers Petrolia Plant - No. 3 Reservoir Dam is located in Fairview Township, Butler County, Pennsylvania approximately 2000 feet north from the center of Petrolia, Pennsylvania. The Koppers Petrolia Plant is located immediately north of Petrolia, Pennsylvania and to the east of PA Route 268. The No. 3 Reservoir Dam is located approximately 1000 feet upstream from the east side of the plant. The coordinates of the dam are N. 41° 01.3', W 79° 42.7'.

c. Size Classification - The maximum height of the dam is 59 feet. The reservoir volume to the top of the dam at El. 1248.0 feet is 278 acre-feet. Therefore, the dam is in the "Intermediate" size category.

d. Hazard Classification - Many lives could be lost in the event of a failure of Koppers Petrolia Plant - No. 3 Reservoir Dam because of the Koppers Petrolia Plant located 1000 feet downstream of the dam. Therefore, this dam is considered in the "High" hazard category.

e. Ownership - The dam and reservoir are owned by the Koppers Company, Inc., Organic Materials Division, Petrolia, Pennsylvania.

f. Purpose of Dam - The dam and reservoir are used for water supply to the Koppers Petrolia Plant.

g. Design and Construction History - The dam was designed by E. D'Appolonia Consulting Engineers, Inc., of Pittsburgh, Pennsylvania. The dam was constructed by Ram Construction Company of Canonsburg, Pennsylvania from July 1974 to final acceptance in January 1975. However, all concrete work was done by the Koppers Company, Inc.

h. Normal Operational Procedures - Normal pool (crest elevation of the principal spillway riser unit) is at El. 1240.0 feet. However, during dry seasons, the pool is usually drawndown because of water usage. The dam is visited frequently (at least daily) and maintenance is performed on an as-needed basis.

1.3 PERTINENT DATA

a. Drainage Area (square miles) -	0.59
b. Discharge at Dam Site (c.f.s.) -	
Maximum Flood -	Unknown
Principal Spillway Capacity (At Maximum Design Pool El. 1246.7 ft.[1]) -	430
Emergency Spillway Capacity (At Maximum Design Pool El. 1246.7 ft.) -	1903
Total Spillway Capacity (At Maximum Design Pool El. 1246.7 ft.) -	2333
c. Elevation (feet above M.S.L.) -	
Design Top of Dam -	1248.0
Minimum Top of Dam -	1247.8
Normal Pool (Crest of Intake Riser Weir) -	1240.0
Maximum Design Pool -	1246.7
Maximum Pool (Phase I Analysis[2]) -	1245.6
Emergency Spillway Crest (without Fuse Plug[3]) -	1240.5
Emergency Spillway Crest (with Fuse Plug) -	1242.8
Streambed at Centerline of Dam -	+1189
Maximum Tailwater -	Unknown
d. Reservoir (feet) -	
Length of Maximum Pool -	1750
Length of Normal Pool -	1600
e. Storage (acre-feet) -	
Top of Dam (El. 1248.0 ft.) -	278
Normal Pool (El. 1240.0 ft.) -	181
f. Reservoir Surface (acres) -	
Top of Dam (El. 1248.0 ft.) -	14
Normal Pool (El. 1240.0 ft.) -	11.45

[1]Elevations are based on Mean Sea Level (M.S.L.).
[2]See Appendix D.
[3]Top of Concrete Slab in Emergency Spillway.

g. Dam -

Type -	Zoned earthfill
Length (feet) -	710
Height (feet) -	59
Top Width (feet) -	20
Side Slopes - Upstream (with a 6 foot wide bench at El. 1225.0 ft.) -	2.5H:1V[4]
Downstream -	2.5H:1V

Zoning - Four different zones (Plate 5, A through D) of material were used in the embankment. The impervious core (Zone A) consisted of weathered claystone with residual clays and weathered shales at higher elevations in the embankment. Zone B consisted primarily of weathered shales and siltstones. Zone C was constructed by interlaying of the Zone B and Zone D material. Zone D consisted of a mixture of weathered sandstone and residual sandy silt.

Impervious Core - Zone A, weathered claystone.

Cut-off - A 6 foot minimum width cut-off trench was installed beneath the embankment along the centerline of the dam. This trench was excavated into the shale below the dam (see Plate 5 for profile of the bottom of the cut-off trench).

Grout Curtain - None

Drains - A drainage trench was installed beneath the downstream embankment with seven perforated collector drain pipes located approximately 2 feet below the foundation line. (See Plates 5 and 9 for details of the drainage system.) A rockfill toe was installed downstream of the drain trench from Station 3+00 to Station 4+62.

h. Diversion and Regulating Tunnel - None

i. Principal Spillway -

Type -	Two-way covered riser with overflow weirs
Length of Two Weirs (feet) -	12.0 ft. ea.
Vertical Clearance (feet) -	2.5
Crest Elevation (feet M.S.L.) -	1240.0
Gates -	None

Outlet Pipe - A 48 inch inner diameter prestressed concrete pressure pipe supported on a reinforced concrete cradle. Six reinforced concrete anti-seep collars were

[4]Horizontal to Vertical

provided at 25 foot centers. The 222 foot long outlet pipe was installed on a 0.90 percent slope.

Riser Floor Invert Elevation (feet M.S.L.) -	1190.0
Outlet Conduit Exit Invert Elevation (feet M.S.L.) -	1188.0

j. Emergency Spillway -

Type - Chute spillway with rectangular concrete control channel and fuse plug	
Width of Channel (perpendicular to flow) (feet) -	50
Length of Control Section (concrete slab) (feet) -	45
Crest Elevation (concrete slab) (feet M.S.L.) -	1240.5
Fuse Plug - Crest Elevation (feet M.S.L.) -	1242.8
Crest Width (feet) -	5.0
Material - "Easily eroded" sand and topsoil with piping protective PVC liner 6 inches below surface.	
Side Slopes - Upstream -	2H:1V
- Downstream -	2H:1V
Upstream Channel - Riprap-lined reservoir shore	
Downstream Channel - Nine hundred foot long trapezoidal earth and bedrock channel exiting over a steep natural slope, then flowing into the South Branch of Bear Creek.	

k. Regulating Outlets - The primary spillway riser was designed as a two chambered structure. On the upstream side of the riser, a chamber was designed to house the cast-iron intake valves for the water supply system. Four intake pipes at intake El. 1225, 1215, 1205, and 1195 feet extend from intake structures on the upstream embankment slope, through the embankment to the valve chamber, and into the riser chamber (see Plate 6). The top three intake pipes consist of 12 inch inner diameter cast-iron pipe. The bottom pipe is a 24 inch inner diameter concrete pressure pipe. The 24 inch intake and the 48 inch outlet conduit can be used to lower the reservoir when conditions warrant.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Information reviewed for the preparation of this report included the Pennsylvania Department of Environmental Resources (PennDER) file for the dam, information obtained by interviewing the owner's personnel, and information forwarded by the design consultant. This included:

1) Various construction inspection reports by PennDER personnel.

2) "Erosion and Sedimentation Control Plan, Water Supply Dam and Reservoir, Koppers Company, Inc., Organic Chemicals Division, Petrolia, Pennsylvania," dated March 1974 and prepared by E. D'Appolonia Consulting Engineers, Inc. (Available in PennDER's microfiche file for the dam.)

3) "Hydrology and Hydraulic Calculations, Proposed Water Impoundment, Koppers Company, Inc., Petrolia, Pennsylvania," dated May 1974 and prepared by E. D'Appolonia Consulting Engineers, Inc. (Available in the PennDER file.)

4) Weekly (later revised to semi-monthly) Progress Reports prepared by the design consultant's resident inspector. (Available in the PennDER file.)

5) Dam Permit Application Report prepared by PennDER, dated 16 July 1974. (Available in the PennDER file.)

6) "Engineers Report and As-Built Conditions, Water Storage Impoundment, Koppers Company, Inc., Organic Materials Division, Petrolia, Pennsylvania," dated November 1975 and prepared by E. D'Appolonia Consulting Engineers, Inc. (Forwarded by design consultant to Michael Baker, Jr., Inc.)

7) Complete set of "as built" drawings for "Proposed Water Storage Impoundment, Butler County, Pennsylvania, Koppers Company, Inc., Organic Chemical Plant, Petrolia, Pennsylvania," last revision 5 November 1975. (Forwarded by design consultant to Michael Baker, Jr., Inc.)

8) Various other correspondence.

The emergency spillway channel was designed only to carry flow from the reservoir for a storm exceeding a 100-year, six hour recurrence. The fuse plug was designed to wash away when the reservoir exceeds El. 1243.0 feet. The emergency spillway channel is concrete-lined only at the entrance control structure; the remaining 900 foot long trapezoidal channel and cascade section were left unlined because of the improbability of its use and the minimal damage anticipated if it should be used.

2.2 CONSTRUCTION

During construction, a resident engineer was provided by the design consultant and visits to the dam site were performed by the design consultant's project manager. In addition, personnel from PennDER's Pittsburgh Region office visited the dam site occasionally to check on the construction of the dam. Modifications or deviations from the design plans were generally recorded by the resident engineer and incorporated into the "as built" drawings. "As built" drawing No. 73-623-E21 shows the diversion used during the construction and the construction sequence of the dam. The "as built" drawings, the "Engineers Report and As-Built Conditions" report, and the construction progress reports highlight the modifications or changes in the design; however, the major as built changes include the following:

a) Two drift mines which were exposed during excavation for the emergency spillway channel were sealed. The location of the drifts are shown on "as built" drawing No. 73-623-E5. The voids were backfilled with 6 to 8 feet of clay with a face of weathered sandstone fill. Additional exploration was then performed to find any other drifts that might endanger the safety of the dam; however, none were located and the minable coal seam present near the drifts was not present within 300 feet of the centerline of the dam.

b) During construction, it was discovered that the north slope of the reservoir had less than a foot of soil cover over weathered sandstone bedrock. It was decided to cover this slope, the valley bottom, and the south slope with a 2 foot thick blanket of clayey material within a distance of 200 feet from the upstream toe of the embankment. "As built" drawing No. 73-623-E1 shows the plan view of the clay blanket.

c) During construction, changes were made in the zoning materials of the dam. For example, the weathered claystone used in the central core was depleted by the time the embankment reached El. 1220 feet. Therefore, residual clay from the weathered shale was allowed to be used to complete the remaining portion of the core. "As built" drawing No. 73-623-E3 shows the modifications in the construction of the embankment.

As indicated above, other minor modifications to suit field conditions are described in the "Engineers Report and As-Built Conditions" report and on the "as built" drawings.

2.3 OPERATION

No formal records are available for operation of the dam and reservoir. The boilerhouse superintendent visits the dam and reservoir every day to check and record the water level. However, he only maintains the water level records for each current season (approximately March or April through September), after that time the records are discarded. The boilerhouse superintendent is also responsible for observing the dam and reservoir and scheduling maintenance on an as-needed basis.

2.4 EVALUATION

a. Availability - The PennDER File No. 10-74, the "as built" drawings, and the information obtained from the design consultant are readily available for review.

b. Adequacy - The information available is adequate for a Phase I Inspection of this dam.

c. Validity - Observations and measurements performed during the visual inspection indicated only one deviation from the "as built" drawings for this dam. The fuse plug dike as constructed has a minimum top elevation of 1242.8 feet rather than the El. 1242.4 feet shown on the drawings. The difference is that the dike was constructed even across the top rather than the specified V-shaped toward the center of the channel. However, given the uncertainty in predicting when the fuse plug will erode away, this difference will not significantly affect the anticipated performance of the emergency spillway.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General - The dam and its appurtenant structures were found to be in fair overall condition at the time of inspection. The visual inspection was performed on 17 May 1979 and no unusual weather conditions were present. Noteworthy deficiencies are described briefly below. The complete visual inspection check list and field sketch are given in Appendix A.

b. Dam - The embankment has a good cover of crown vetch making the inspection somewhat difficult. No problems were observed in the alignment or stability of the slopes. Seepage was observed exiting the right downstream junction of the dam and abutment near the concrete drainage gutter. Erosion and undermining of the concrete drainage gutter was also observed. Heavy flow was observed exiting the toe drain outlet which drains this area. Seepage was also observed exiting the right hillside approximately 50 feet downstream from the dam. The "as built" drawings indicate numerous springs were observed at this abutment contact and hillside during construction.

c. Apputenant Structures - The riser unit was in good overall condition at the time of inspection. Some corrosion of the valves and other metal surfaces has occurred, but this can be corrected during routine preventive maintenance. The condition of the outlet conduit was examined by walking inside the conduit for the entire length. The joint filler was missing and should be replaced on several of the joints.

The emergency spillway discharge channel was partially blocked by a slide from the right hillside, approximately 350 feet downstream from the fuse plug. Also, a minor amount of debris was present in the channel. The fuse plug dike was in good condition and apparently was not V-notched in center as the design drawings indicated. This makes the minimum top of dyke 0.4 feet higher than designed.

d. Reservoir Area - The side slopes of the reservoir are steep but with good vegetation cover. No unusual sedimentation was observed in the reservoir.

e. Downstream Channel - Located immediately below the dam is Koppers Petrolia Plant - No. 1 Reservoir Dam (not listed in the National Dam Inventory). (See Photos 13 and 14 for a view of the spillway and dam.) Located approximately 1000 feet below the No. 3 Reservoir Dam (or immediately below the No. 1 Reservoir Dam) is the Koppers Petrolia Plant. (See Photo 6 for overall view of the No. 1 Reservoir and Koppers Petrolia Plant located below.) An estimated 150 persons are employed at the plant. The discharges from the dam enter the South Branch of Bear Creek at the plant.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal procedures in the event of impending catastrophe for the dam. The boilerhouse superintendent visits the dam daily to check the water level of the reservoir. Drawdown of the reservoir can be accomplished by using the 24 inch intake pipe and 48 inch outlet conduit.

It is recommended that formal emergency procedures be prepared, prominently displayed, and furnished to all operating personnel.

4.2 MAINTENANCE OF DAM

The maintenance condition of the dam is considered to be fair. There are no formal procedures for evaluating the necessity of maintenance for the structure; however, the boilerhouse superintendent schedules maintenance when he determines it is necessary. It is recommended that formal inspection and evaluation procedures be developed.

4.3 MAINTENANCE OF OPERATING FACILITIES

The operating facilities are considered in satisfactory condition and are adjusted periodically to satisfy the water supply needs of the plant. However, it is recommended that formal preventive maintenance schedules be established to insure continued operation.

4.4 DESCRIPTION OF ANY WARNING SYSTEM

A warning system is presently in effect for the Koppers Plant which has been provided to cover accidents or emergencies at the plant. It is recommended that this plan be adapted to include any impending catastrophe for the dam and revised to include any areas downstream which may also be affected.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data - Hydrologic and hydraulic design data were obtained from the design engineer, E. D'Appolonia Consulting Engineers. The dam was designed in accordance with Soil Conservation Service's (SCS) criteria for a Class B structure. The hydraulic design for this type of structure is essentially equal to the 1/2 Probable Maximum Flood (1/2 PMF). The primary spillway was designed to pass the 100-year six hour storm without activating the emergency spillway. The SCS emergency spillway and freeboard hydrographs were then developed and routed through the reservoir to determine the geometry of the emergency spillway and the crest elevation of the dam, respectively. The freeboard hydrograph was based on a six hour precipitation of 12.8 inches resulting in a peak discharge of 3572 c.f.s. and a maximum reservoir level of 1246.7 feet. El. 1248.0 feet was then chosen as the embankment crest elevation.

b. Experience Data - According to the owners of the dam, the maximum reservoir level was approximately 6 inches above the normal pool El. of 1240.0 feet.

c. Visual Observations - The slide observed on the right side of the emergency spillway channel could cause an obstruction to flood discharges if it is allowed to continue. No other condition was observed that would indicate that the spillway and outlet works could not operate satisfactorily in the event of a flood.

d. Overtopping Potential - Koppers Petrolia Plant - No. 3 Reservoir Dam is classified as a "High" hazard - "Intermediate" size dam requiring evaluation for a spillway design flood (SDF) equal to the Probable Maximum Flood (PMF). The hydrologic and hydraulic capabilities of the reservoir and spillways were evaluated by routing the PMF through the reservoir with the aid of the U.S. Army Corps of Engineers Flood Hydrograph Package, HEC-1. The PMF hydrograph developed as part of this analysis had a peak discharge of 1974 c.f.s. based on a six hour probable maximum precipitation of 22.3 inches. The results of the flood routing indicate that the dam is capable of passing the PMF with a maximum reservoir level of 1245.6 feet, 2.2 feet below the minimum crest of dam elevation of 1247.8 feet.

e. Spillway Adequacy - The dam, as outlined in the above analysis, is capable of passing the PMF without overtopping. Therefore, the spillway is "adequate" according to the recommended criteria.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - The seepage (from the toe drain) observed has been determined by previous studies to be partially responsive to fluctuations in the reservoir level; however, the majority of the flow was present after construction and before reservoir filling. The seepage observed exiting under and around the drainage gutter should not be allowed to cause the erosion and undermining that is presently occurring. It is recommended that measures be taken to eliminate or minimize the erosion and undermining.

b. Design and Construction Data - The stability of the embankment was checked by the design consultant using a computerized version of Bishop's Method of Slices. The results of the stability analyses, including the critical potential failure arcs, are shown on design drawing No. 73-623-E18 (included in this report as Plate 10). The minimum factor of safety obtained for the rapid drawdown condition for the upstream slope was found to be 1.30. A minimum factor of safety of 1.52 for the steady state seepage conditions was obtained. These factors of safety are considered adequate according to "The Recommended Guidelines for Safety Inspection of Dams."

c. Operating Records - Nothing in the readily available operating information indicates cause for concern relative to the structural stability of the dam.

d. Post-Construction Changes - There have been no post-construction changes to the dam which affect the structural stability.

e. Seismic Stability - The dam is located in Seismic Zone 1 of the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." This is a zone of very low seismic activity. Experience indicates that dams in this zone will have adequate stability under seismic loading conditions provided static stability conditions are satisfied and conventional safety margins exist. Koppers Petrolia Plant - No. 3 Reservoir Dam has been shown to meet the conventional static stability requirements; therefore, further consideration of the seismic stability is not warranted.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety - The dam was found to be in fair overall condition at the time of inspection. The dam is a "High" hazard - "Intermediate" size dam requiring a spillway capacity equal to the PMF. As presented in Section 5, the spillways and reservoir are adequate to pass the PMF without overtopping the dam.

b. Adequacy of Information - The information available and the observations made during the field inspection are considered sufficient for this Phase I Inspection Report.

c. Urgency - The owner should initiate the action discussed in paragraph 7.2 without delay.

d. Necessity for Additional Data/Evaluation - It is recommended that the owner engage the services of a qualified professional engineer to develop recommendations to control the seepage at the right abutment.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection revealed certain items of remedial work which should be performed by the owner. These include:

1) The owner should engage the services of a qualified professional engineer to develop appropriate measures to control the seepage exiting at the right abutment junction to prevent erosion and undermining.

2) Repair the slide area on the right hillside to prevent blockage of the emergency spillway channel.

3) Provide riprap for the erosion ditch along the right hillside (running into the discharge channel).

4) Repair the toe drain outlet animal guards and repair the pipe where disjointed.

5) Replace the joint filler in the outlet conduit where necessary.

6) Restore the top of dam near the emergency spillway training wall to the original design elevation.

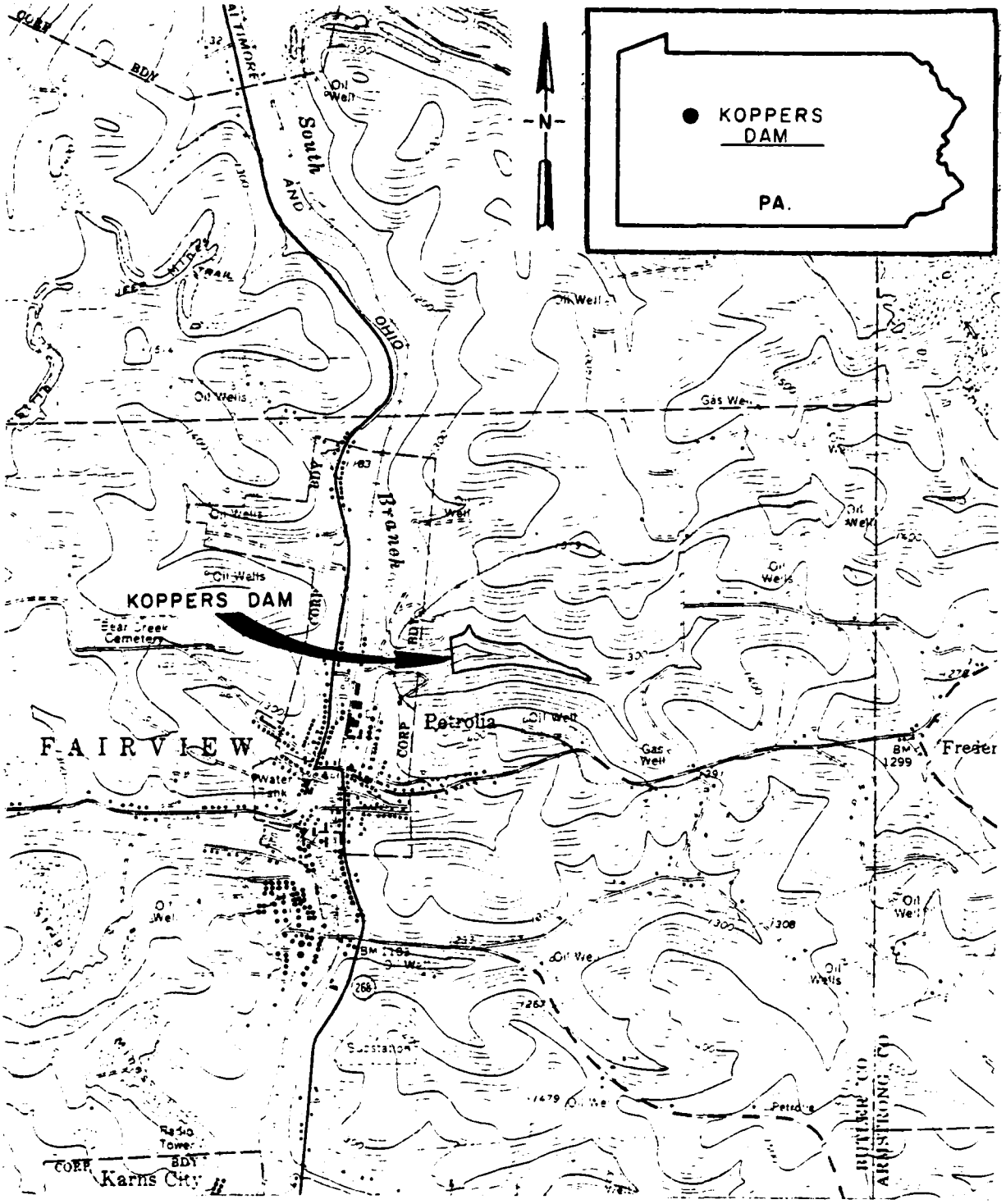
In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

PLATES



SCALE 1:24000

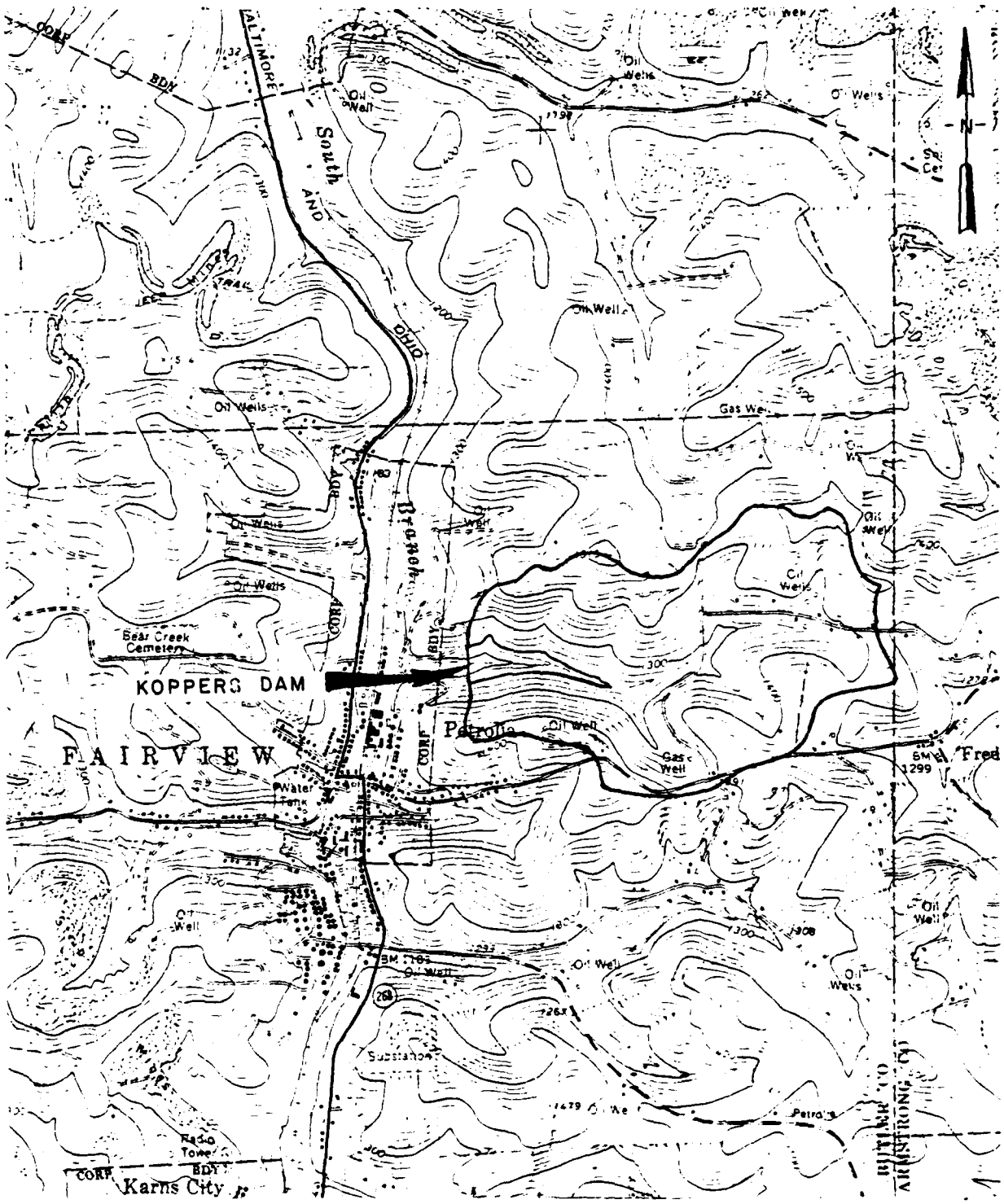
1 1/2 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

PLATE 1 LOCATION PLAN

KOPPERS DAM



SCALE 1:24000

1/2 0 1 MILE

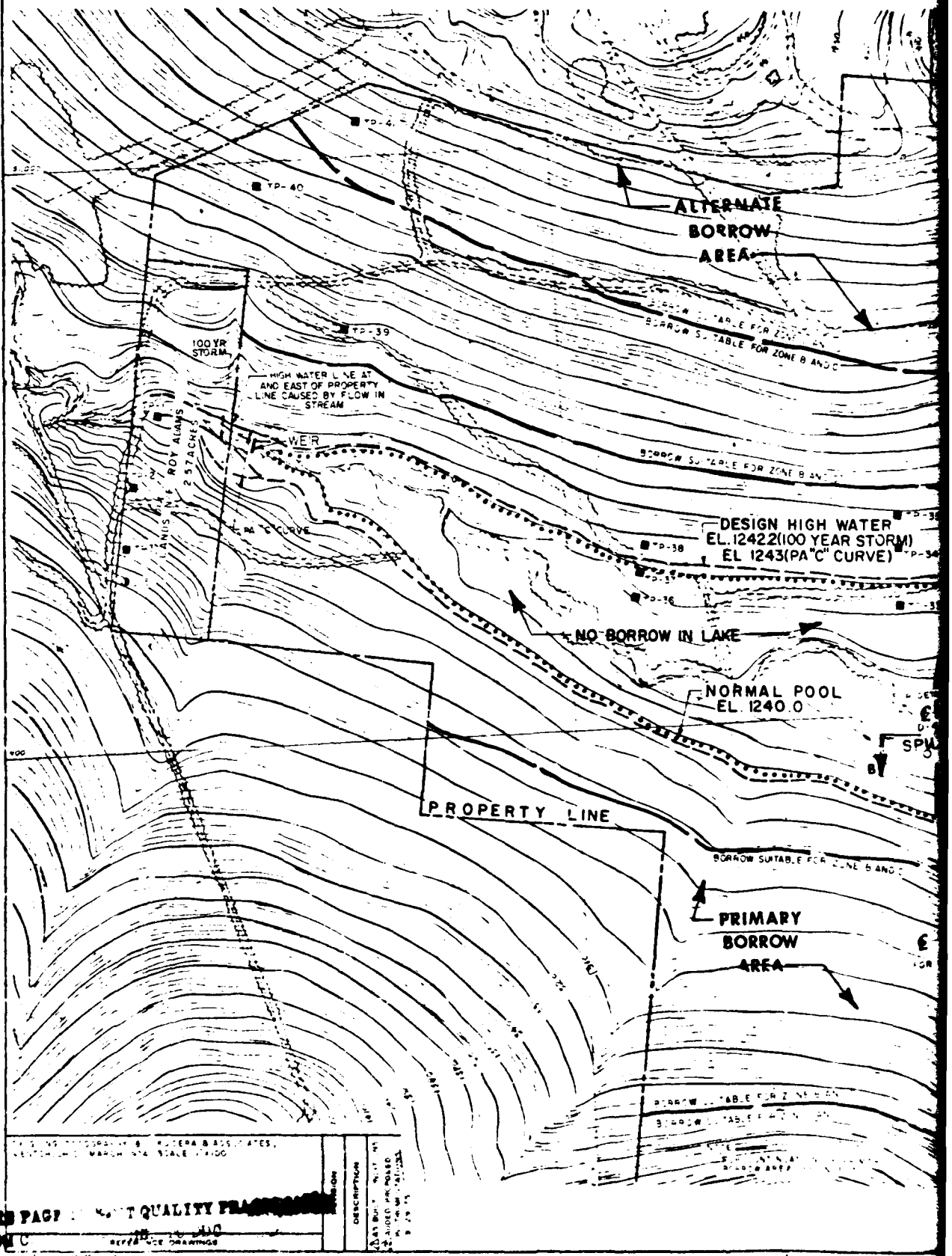
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

PLATE 2 WATERSHED MAP

KOPPERS DAM

73-623-E1



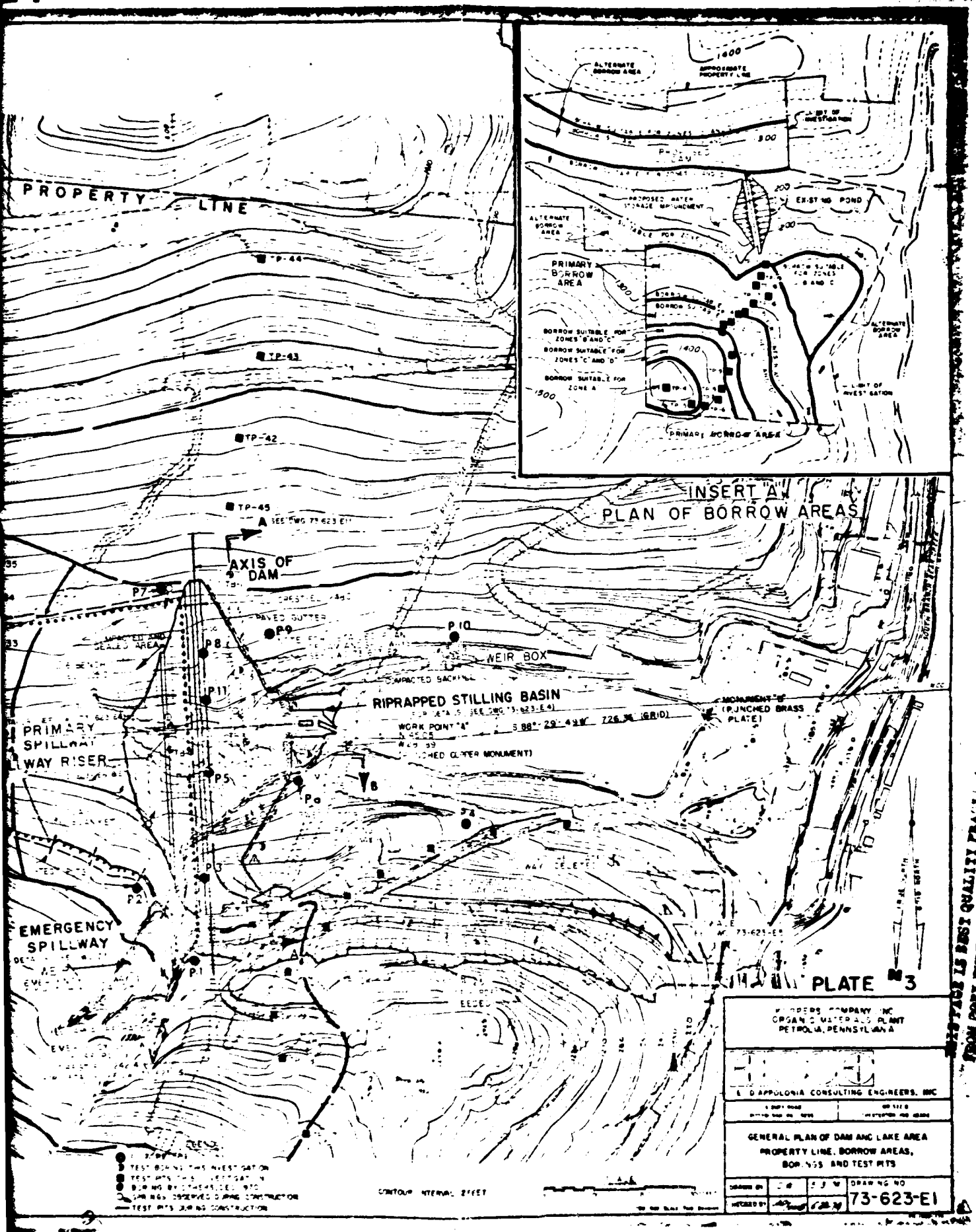
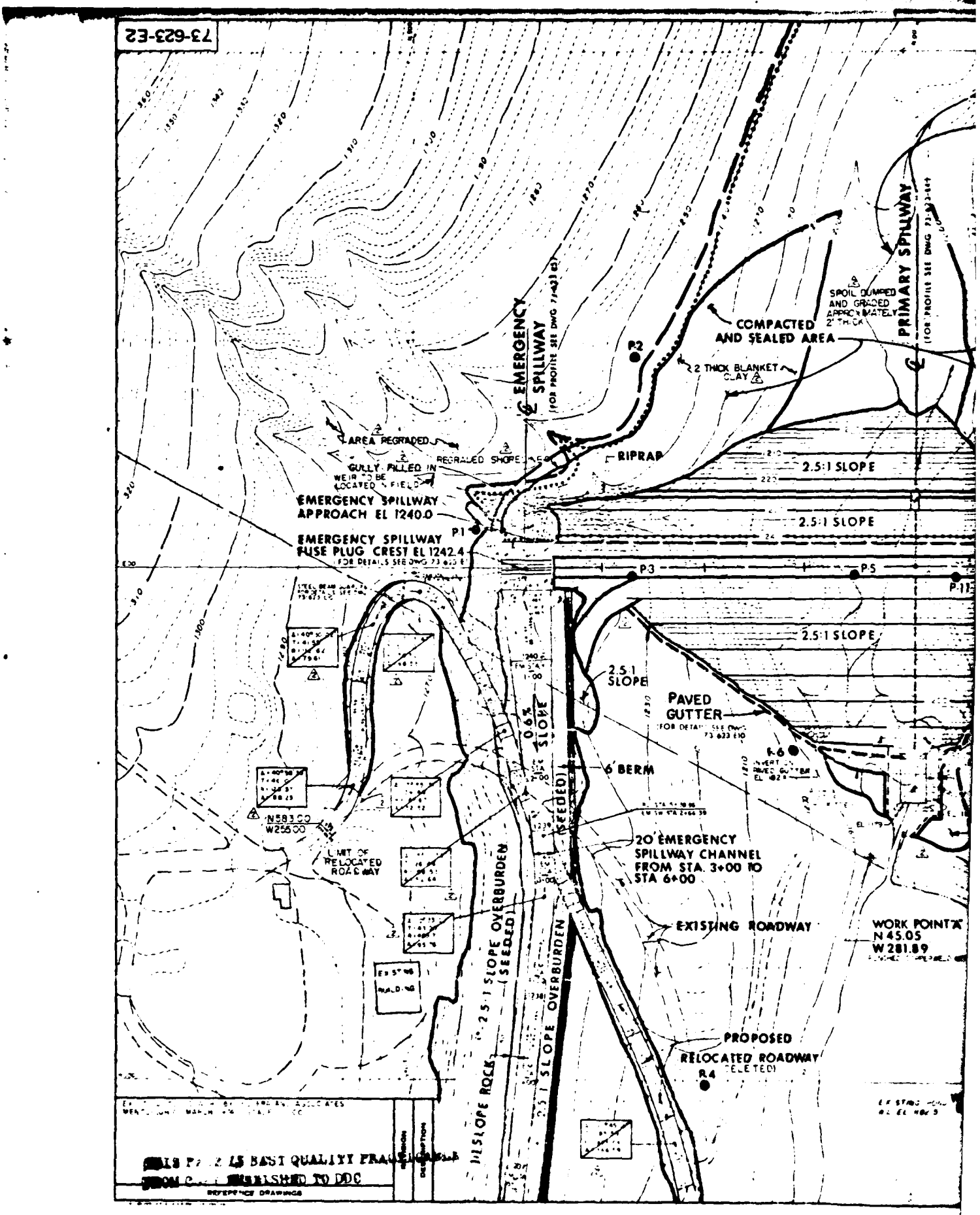


PLATE 3

ENGINEERS COMPANY INC ORGANIC WASTE AID PLANT PETROLIA, PENNSYLVANIA	
E. D'APPOLONIA CONSULTING ENGINEERS, INC	
GENERAL PLAN OF DAM AND LAKE AREA PROPERTY LINE, BORROW AREAS, BORINGS AND TEST PITS	
DESIGNED BY: [illegible] DRAWN BY: [illegible] CHECKED BY: [illegible]	DRAWING NO. 73-623-E1



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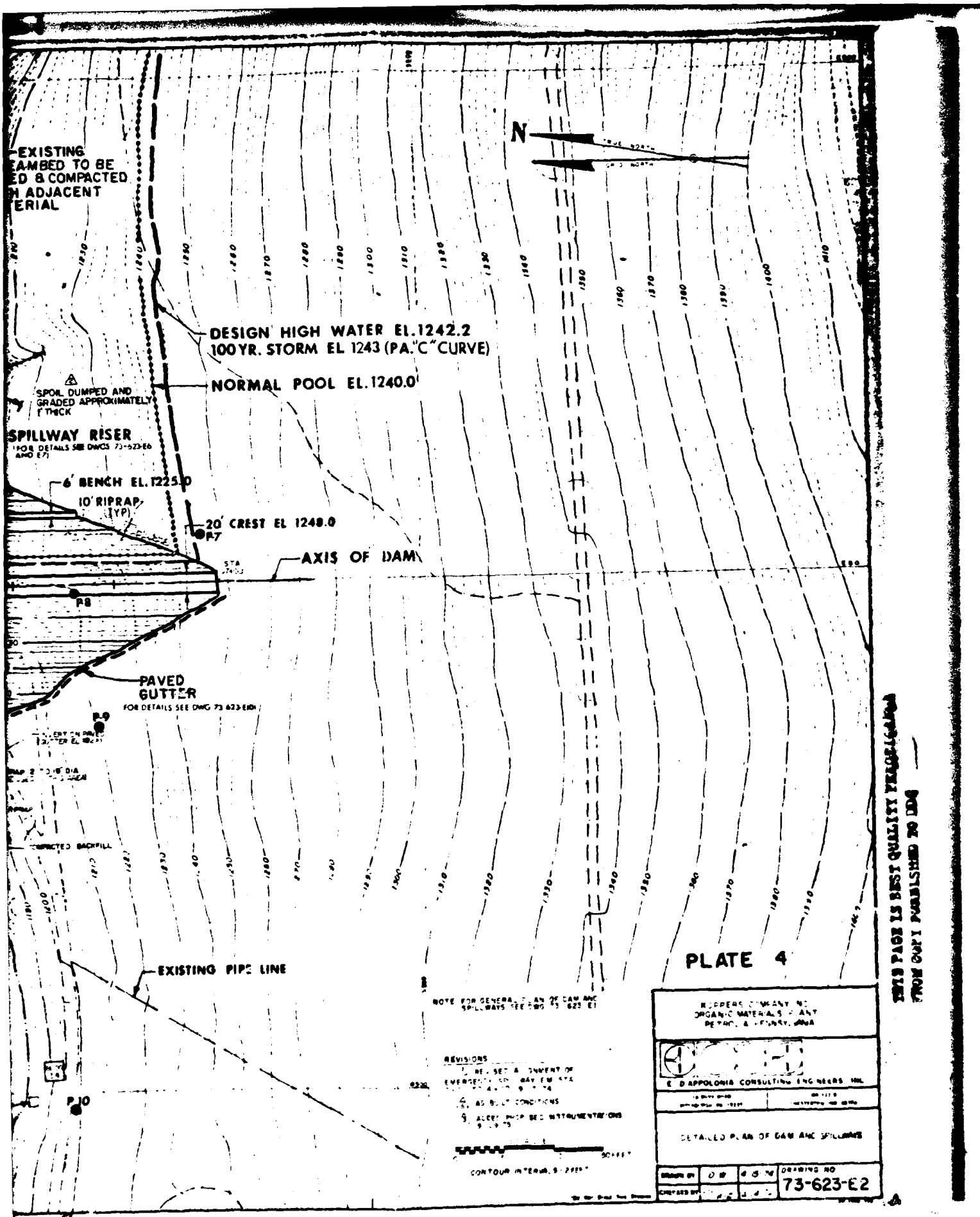
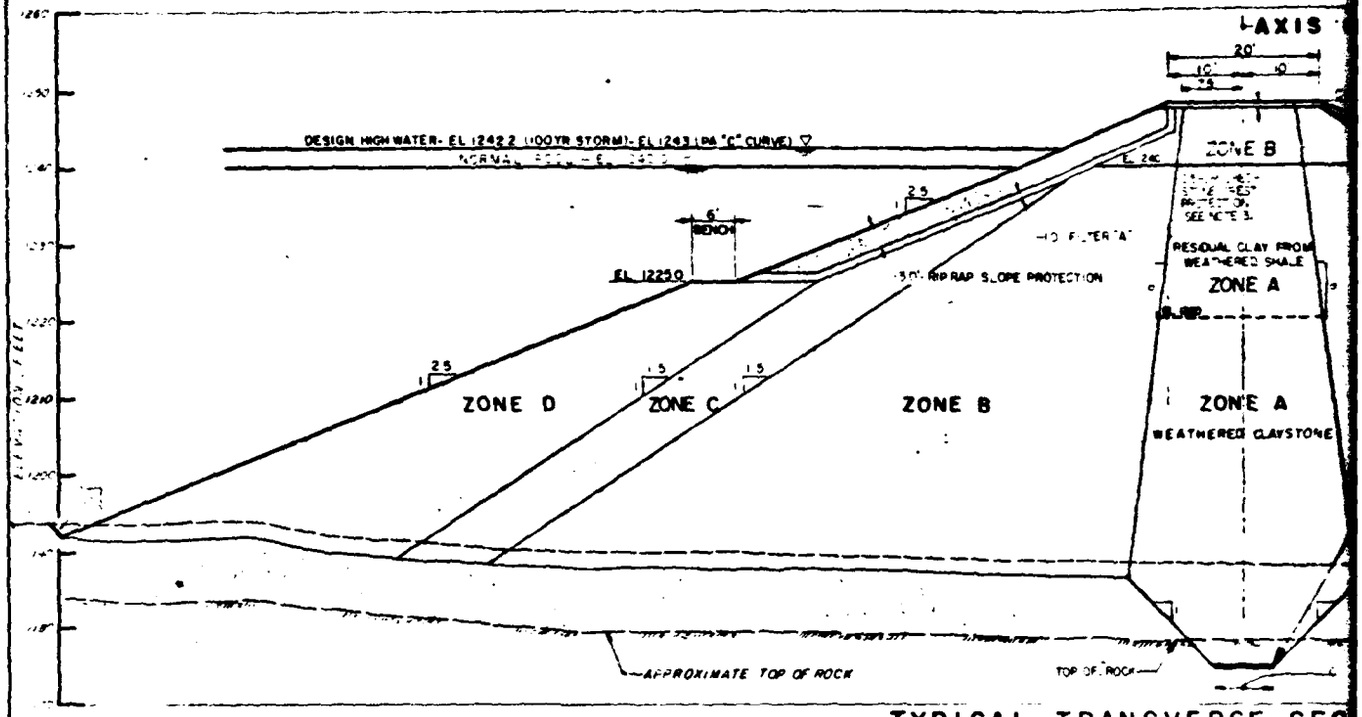
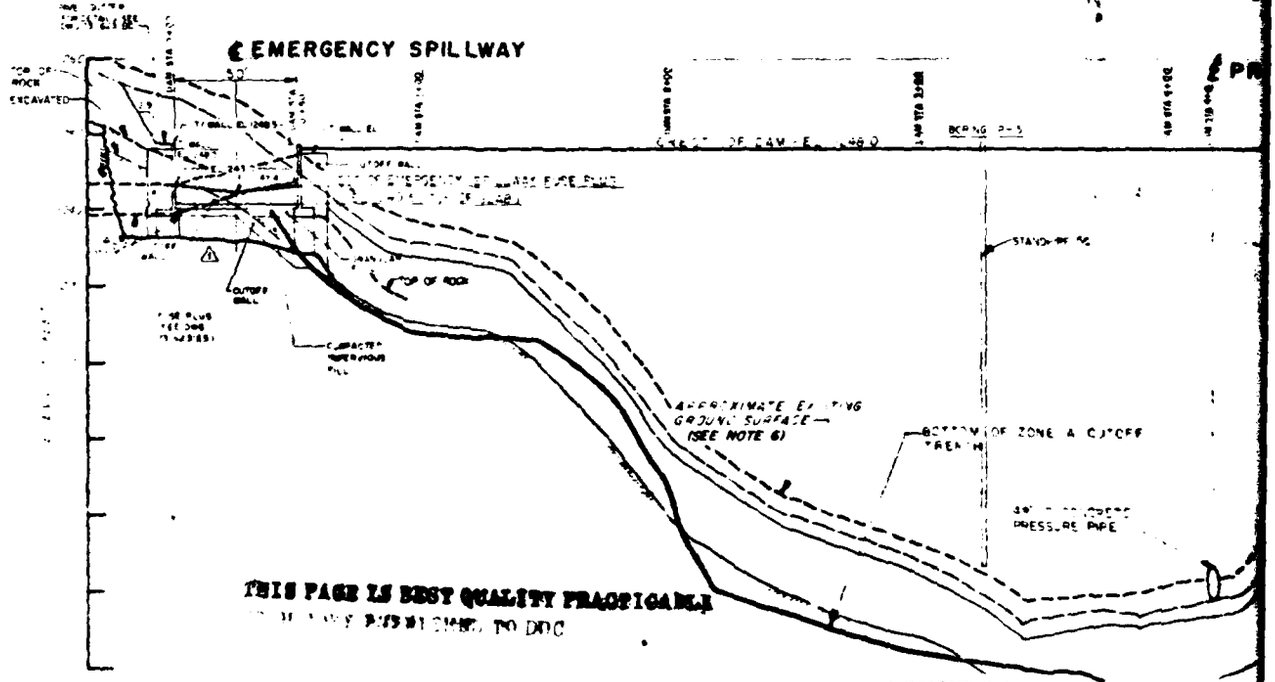
FROM COPY FURNISHED TO DDC



73-623-E3

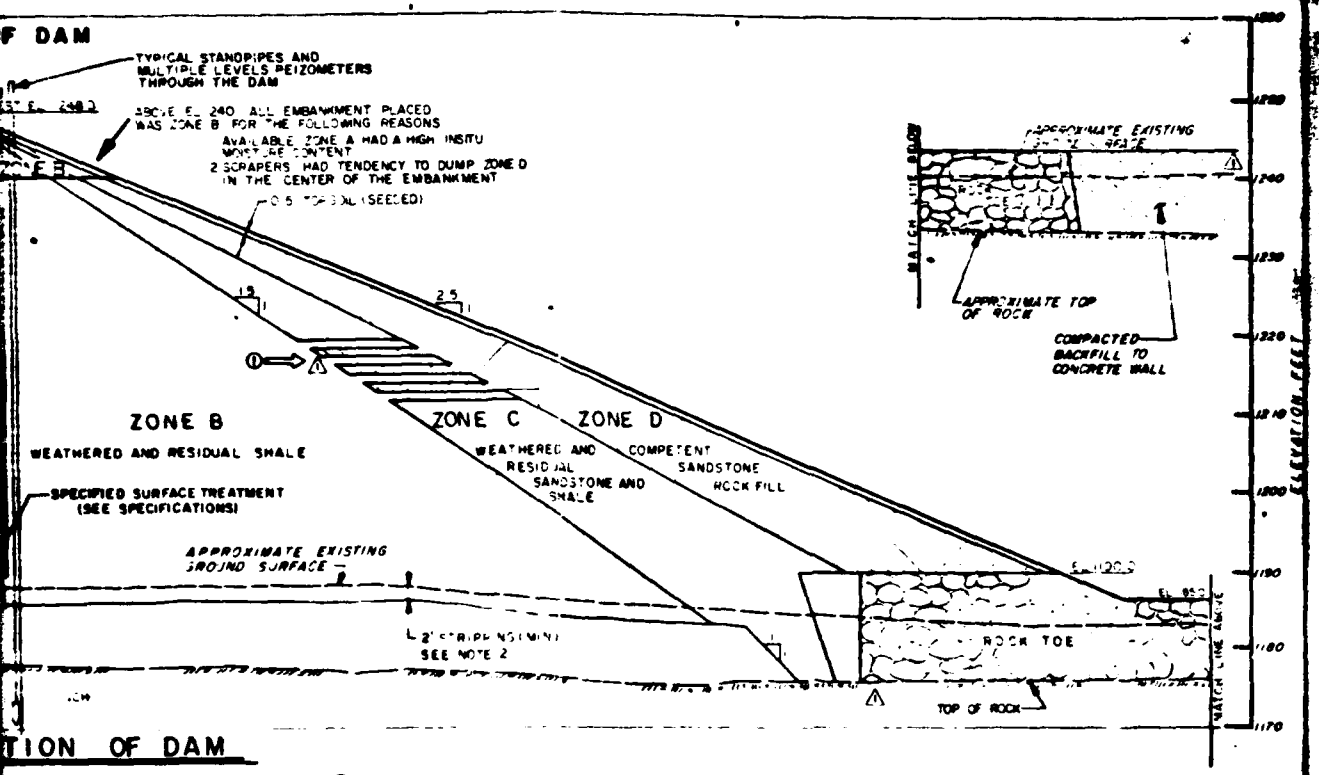


TYPICAL TRANSVERSE SEC



LONGITUDINAL SECTION ALONG

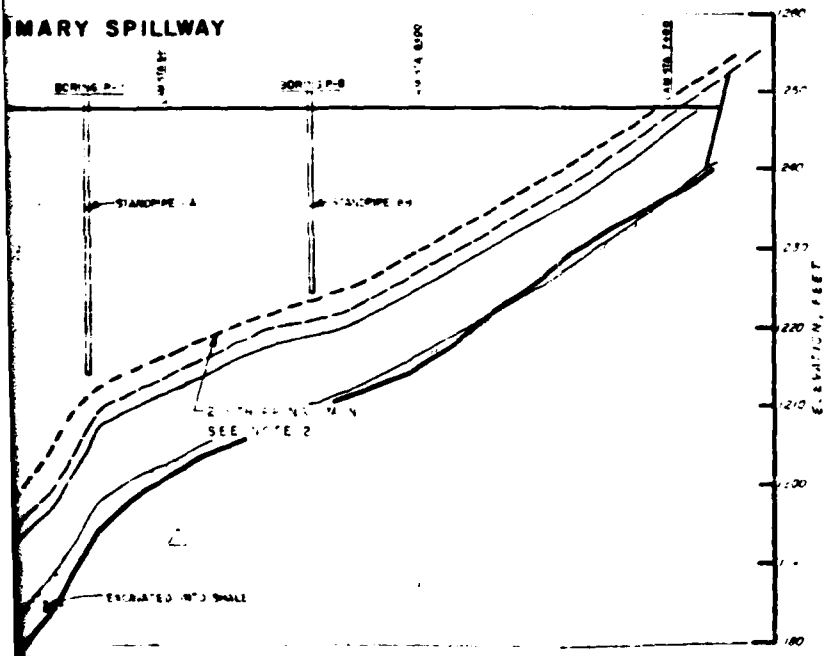
F DAM



TION OF DAM

① CONTRACTOR CHOSE TO CHANGE BORROW AREAS RATHER THAN USE THE ROCK PARE (SIC) AS A RESULT BECAME AN AREA OF INTERBEDDED ZONES B AND D IN BOTH SIDES OF THE CORE

MARY SPILLWAY



E AXIS OF DAM

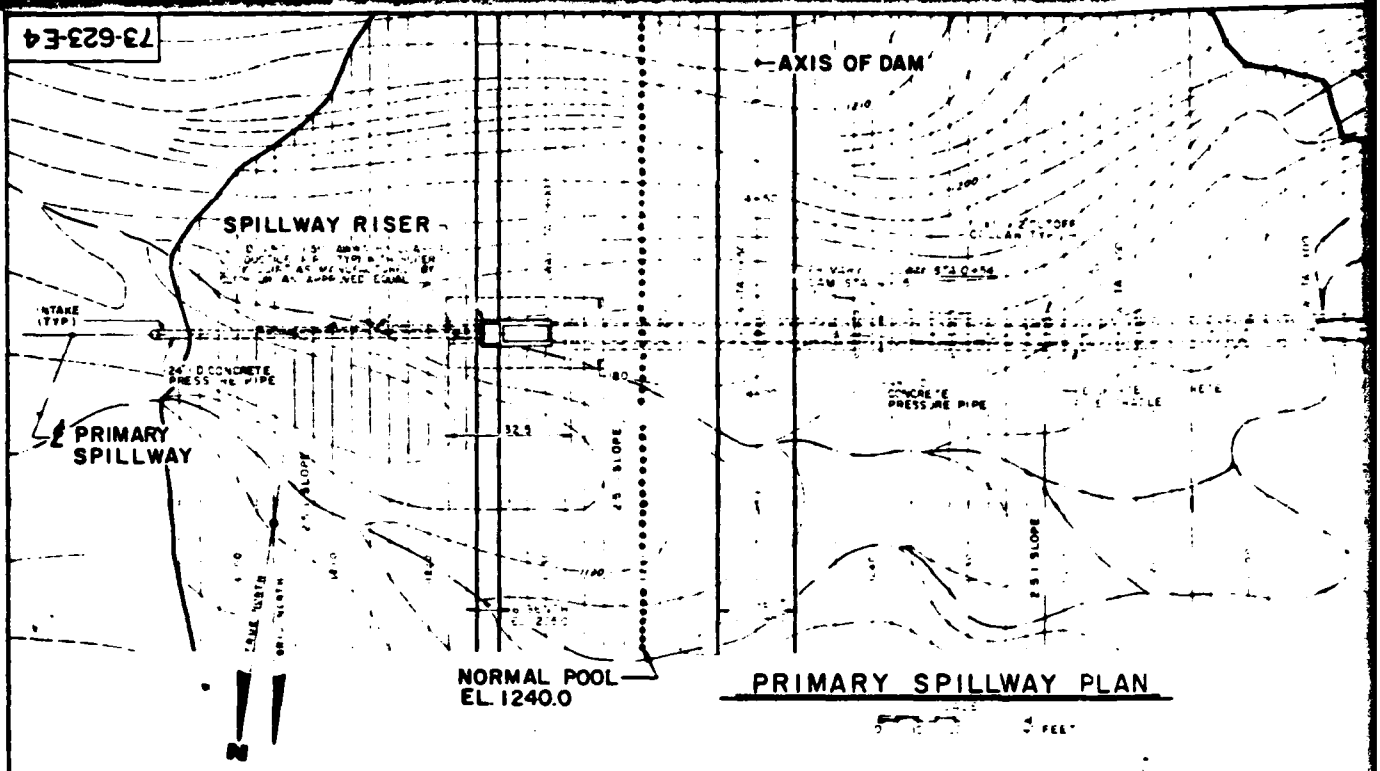
NOTES

1. FOR DETAILED PLAN OF DAM AND SPILLWAYS SEE DWG 73-623-E2
2. THE DESIGN STRIPPING DEPTH UNDER THE EMBANKMENT IS 2 FEET ADDITIONAL UNSUITABLE MATERIAL SHALL BE REMOVED AS DIRECTED BY THE FEC ENGINEER
3. THE CREST PROTECTION SHALL BE PLACED IN 2 STAGES THE 1ST STAGE SHALL BE KEYED INTO THE CREST OF THE DAM SET NO STAGE SHALL BE PLACED ON THE ROCK SURFACE
4. FOR GRADATION SIZE SPECIFICATIONS FOR ZONES A, B, C, D, SEE DWG 73-623-E6
5. SEE DWG 73-623-E22 FOR WIDTH OF BOTTOM OF CUT OFF TRENCH
6. THERE IS A 3.0 FT. DIFFERENCE IN ELEVATION BETWEEN PLAN AND ACTUAL TOPOGRAPHY ACTUAL ELEVATIONS ARE

KOPPERS COMPANY, INC. ORGANIC MATERIALS PLANT PETROLIA, PENNSYLVANIA	
E. D'APPOLONIA CONSULTING ENGINEERS, INC.	
TYPICAL SECTIONS OF DAM	
DESIGN BY AS	DRAWING NO 73-623-E3
CHECKED BY	

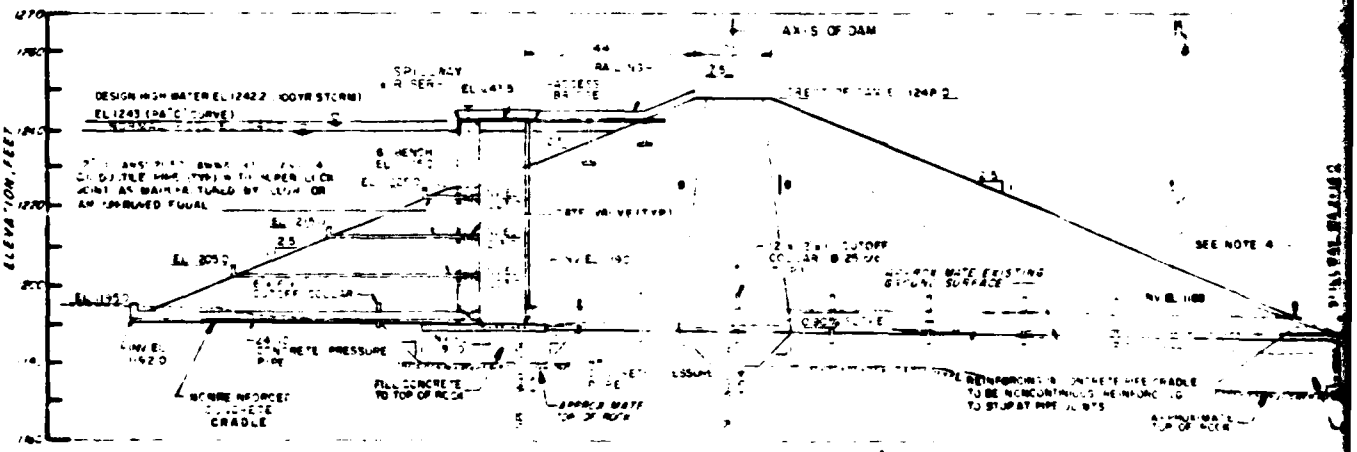
PLATE 5

73-623-E4



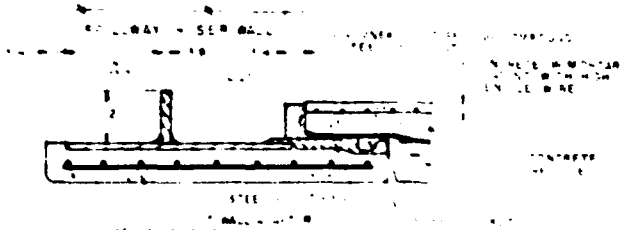
PRIMARY SPILLWAY PLAN

FEET



PROFILE ALONG ℄ OF PRIMARY SPILLWAY

FEET



DETAIL OF SPIGOT WALL ADAPTOR

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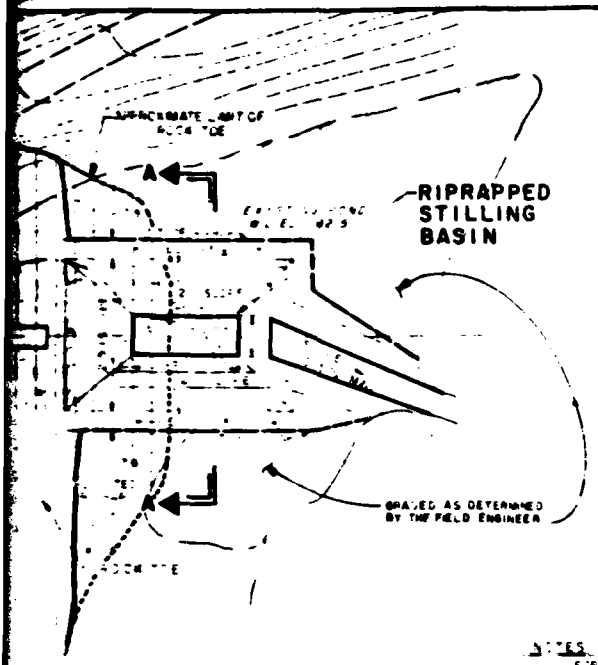
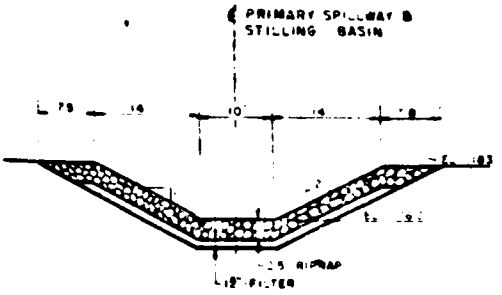
REFERENCE DRAWINGS



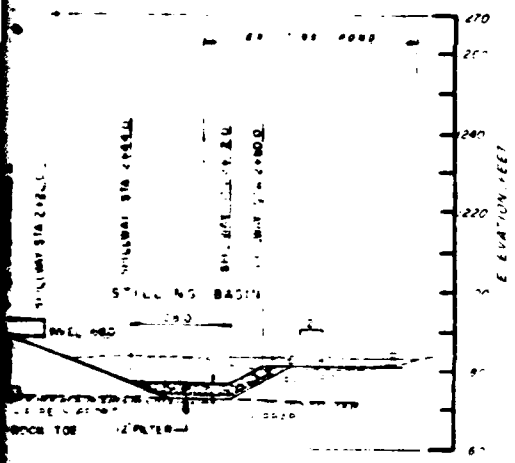


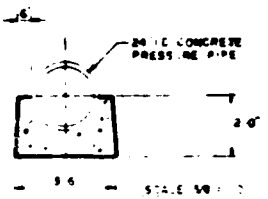
SECTION A-A

SCALE
0 10 20 FEET

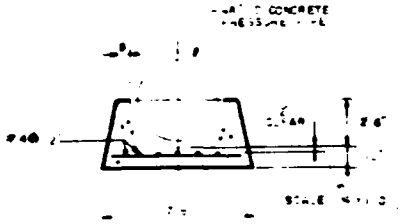
NOTES

1 FOR GENERAL LOCATION OF PRIMARY SPILLWAY SEE DWG 73-623-E1
2 FOR STRUCTURAL DETAILS OF PRIMARY SPILLWAY SEE DWGS 73-623-E6 & E7
3 FOR DETAILS OF INTAKE STRUCTURES SEE DWG 73-623-E8
4 42 INCH I.D. CONCRETE PRESSURE PIPE TO BE TIED TO CONCRETE CRADLE (SEE DWG 73-623-E10)
5 FOR STRUCTURAL DETAILS OF CUTOFF COLLAR AND PIPE SUPPORT (SEE DWG 73-623-E10)

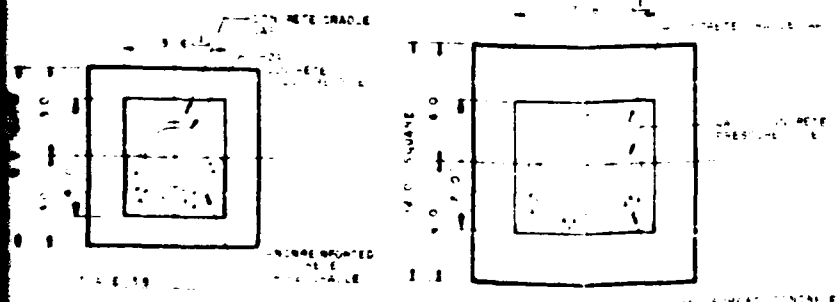




DETAIL OF NONREINFORCED
CONCRETE PIPE CRADLE



DETAIL OF REINFORCED
CONCRETE PIPE CRADLE



DETAIL OF CUTOFF COLLARS

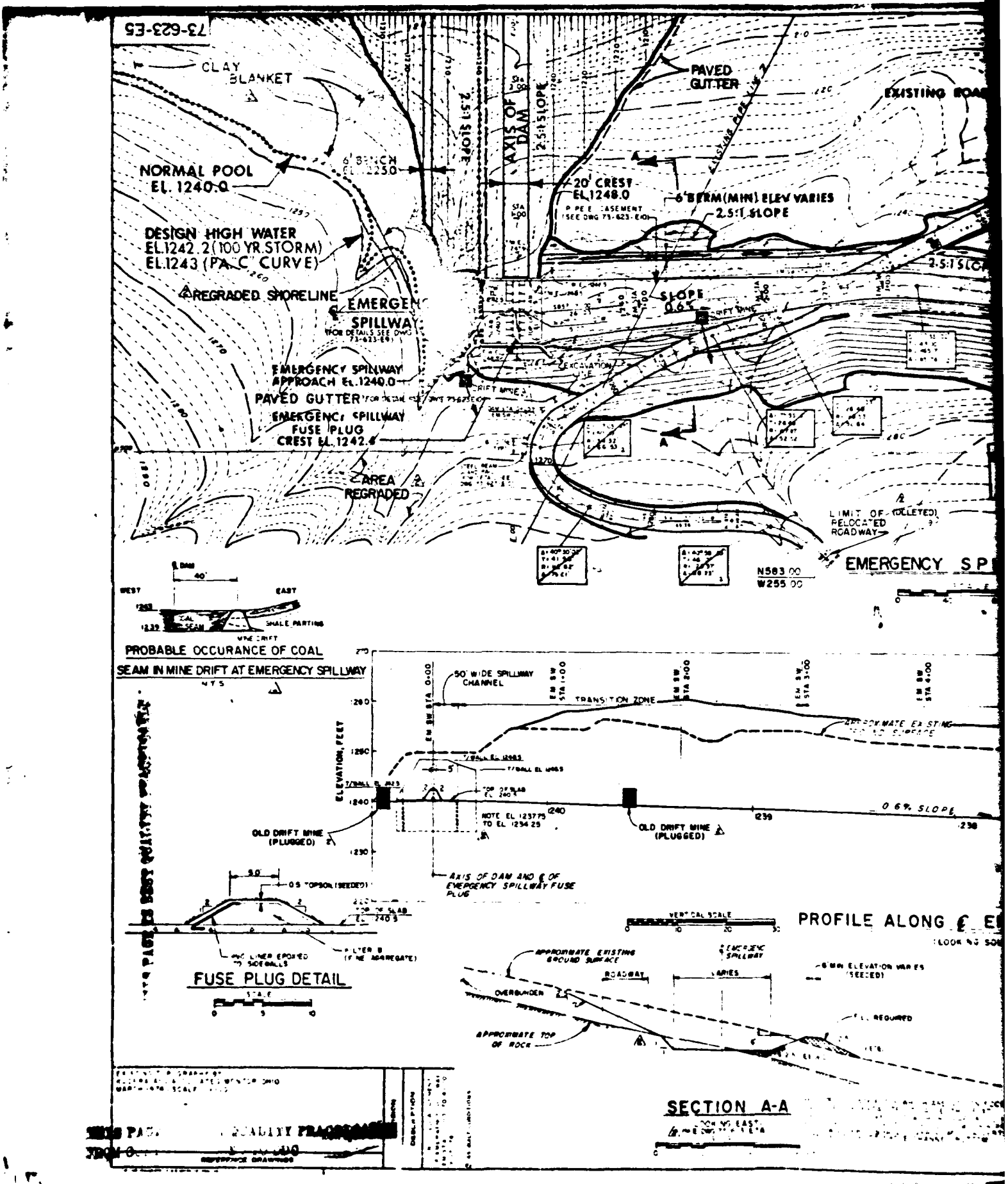
PLATE 6

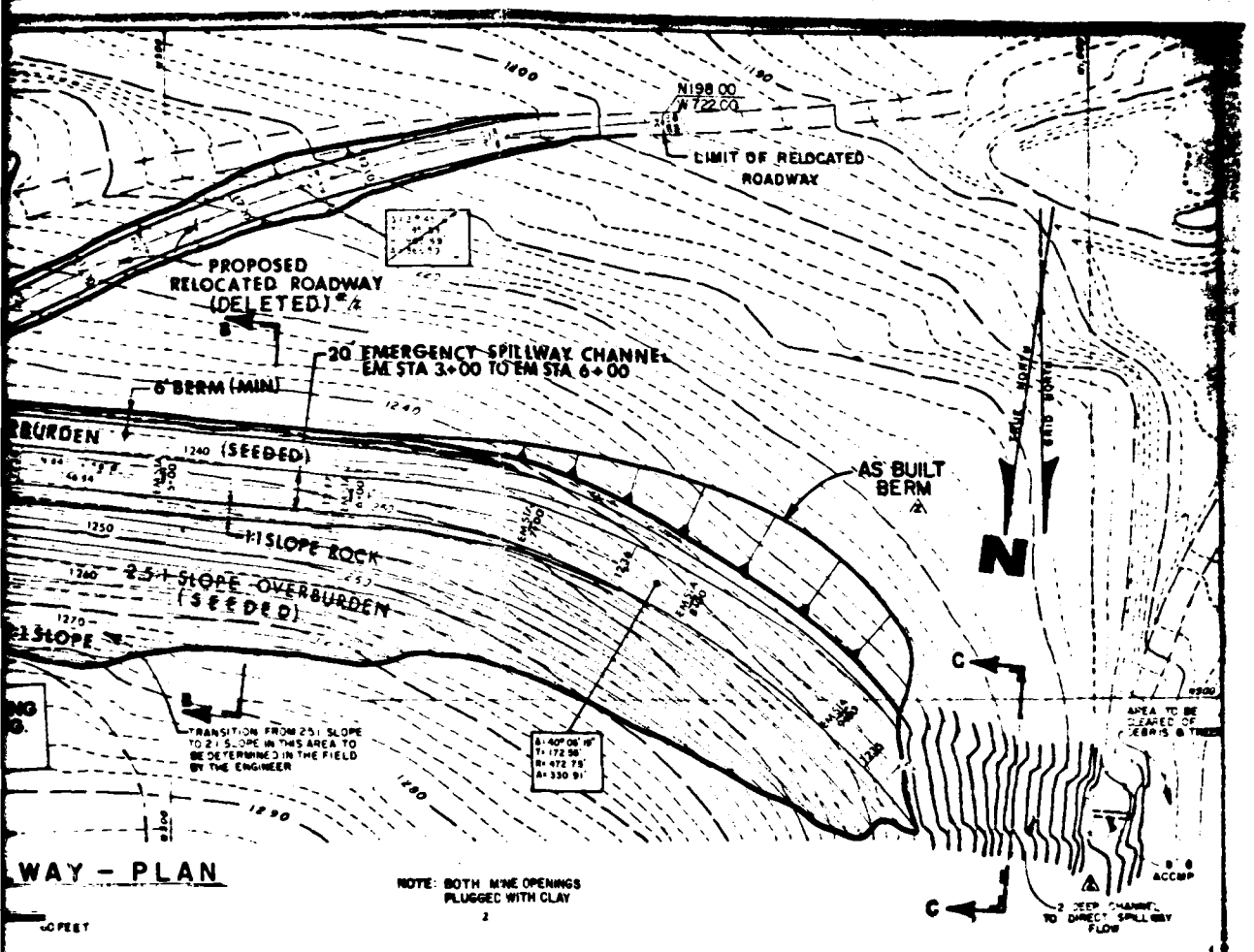
Record Copy 3/20/75

WATERWAYS EXPERIMENT STATION
VICKSBURG, MISSISSIPPI

A. D. APPOLONIA CONSULTING ENGINEERS, INC.

DRAWING NO
73-623-E4

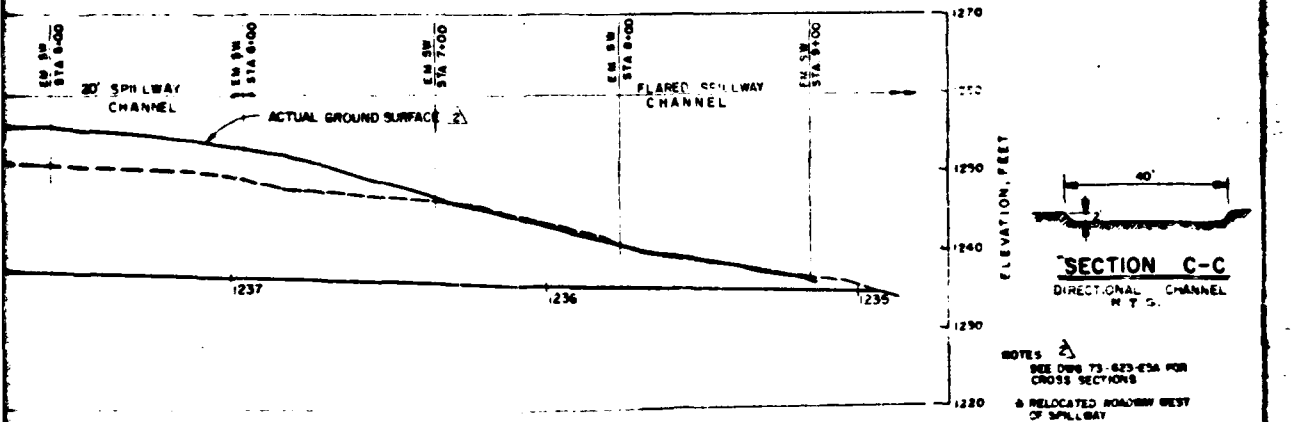

73-623-E5
CLAY BLANKET
NORMAL POOL EL. 1240.0
DESIGN HIGH WATER EL.1242.2 (100 YR.STORM) EL.1243 (PA.C' CURVE)
REGRADED SHORELINE
EMERGENCY SPILLWAY
EMERGENCY SPILLWAY APPROACH EL.1240.0
PAVED GUTTER
EMERGENCY SPILLWAY FUSE PLUG CREST EL.1242.6
AREA REGRADED
6' BERM EL.1250
2.5:1 SLOPE
AXIS OF DAM
20' CREST EL.1248.0
6' BERM (MIN) ELEV VARIES
2.5:1 SLOPE
PAVED GUTTER
EXISTING ROAD
SLOPE 0.6%
DRIFT MINE
EXCAVATION LINE
LIMIT OF RELOCATED ROADWAY (DELETED)
EMERGENCY SPILLWAY
N583.00
W255.00
PROBABLE OCCURANCE OF COAL SEAM IN MINE DRIFT AT EMERGENCY SPILLWAY
WEST
EAST
COAL SEAM
SHALE PARTING
MINE DRIFT
50' WIDE SPILLWAY CHANNEL
TRANSITION ZONE
APPROXIMATE EXISTING GROUND SURFACE
ELEVATION, FEET
0.6% SLOPE
OLD DRIFT MINE (PLUGGED)
OLD DRIFT MINE (PLUGGED)
AXIS OF DAM AND ℄ OF EMERGENCY SPILLWAY FUSE PLUG
0.5 TOPSOIL (SEEDED)
FILTER B (FINE AGGREGATE)
FUSE PLUG DETAIL
SCALE
VERTICAL SCALE
PROFILE ALONG ℄ EMERGENCY SPILLWAY
APPROXIMATE EXISTING GROUND SURFACE
ROADWAY
OVERBURDEN
APPROXIMATE TOP OF ROCK
SECTION A-A



WAY - PLAN

NOTE: BOTH MINE OPENINGS PLUGGED WITH CLAY 2

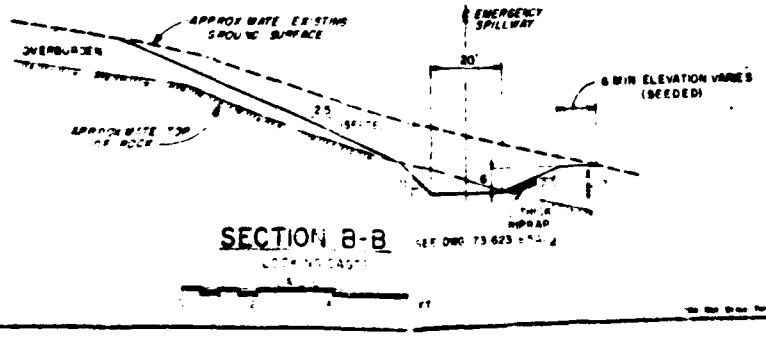
60 FEET



SECTION C-C
DIRECTIONAL CHANNEL
N T S.

NOTES 2
SEE DWG 73-623-E5A FOR CROSS SECTIONS
6 RELOCATED ROADWAY WEST OF SPILLWAY

RGENCY SPILLWAY



SECTION B-B

PLATE 7

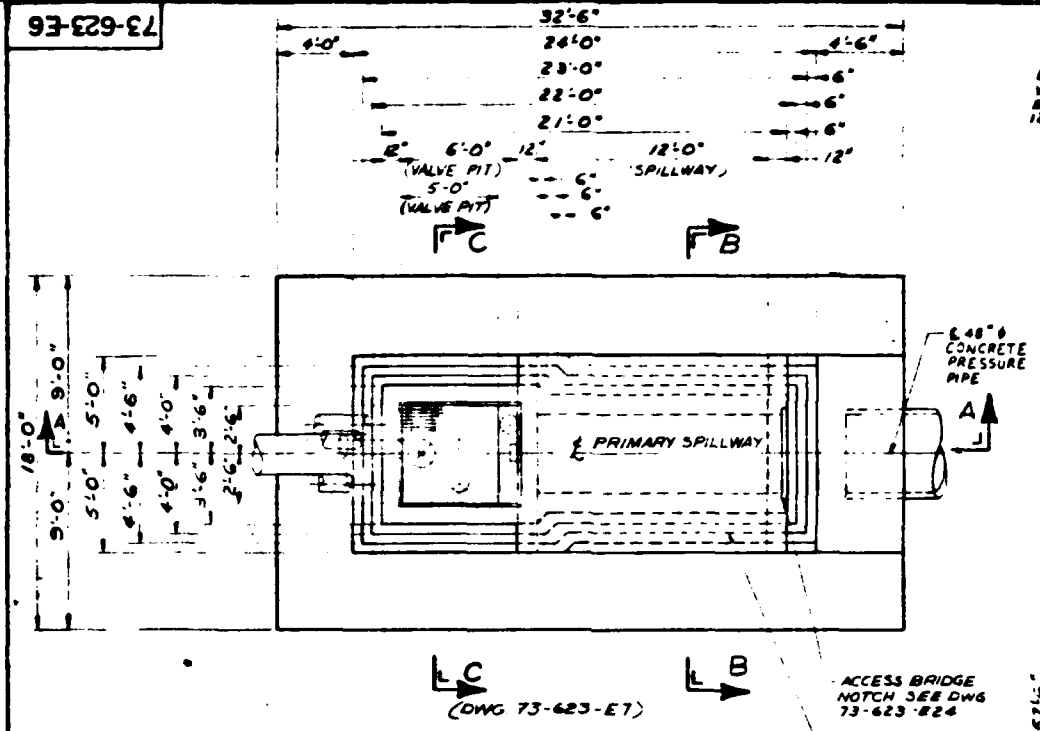
ROPPERS COMPANY INC
ORGANIC WATER A.S. PLANT
PETERSBURG, VIRGINIA

E. B. APPOLONIA CONSULTING ENGINEERS, INC

PLAN AND PROFILE OF EMERGENCY SPILLWAY

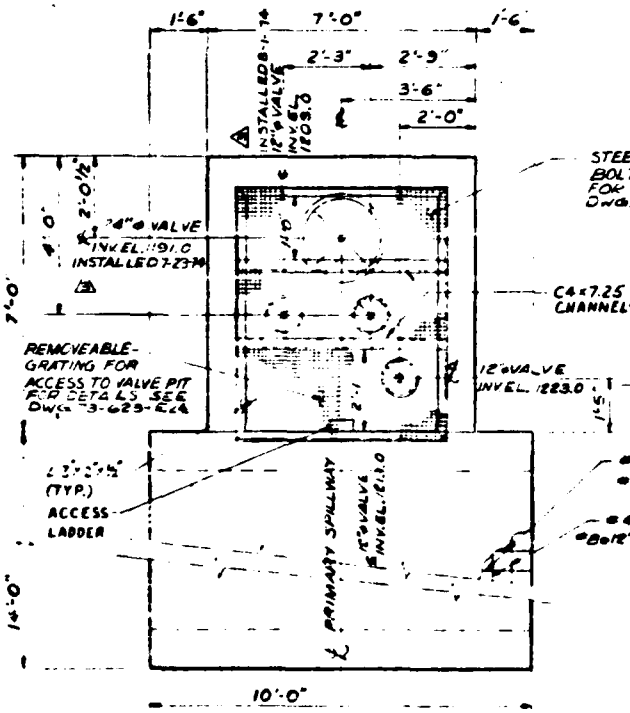
DRAWING NO
73-623-E5

73-623-E6



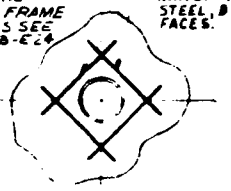
PLAN-PRIMARY SPILLWAY

SCALE 1/8"-1'-0"



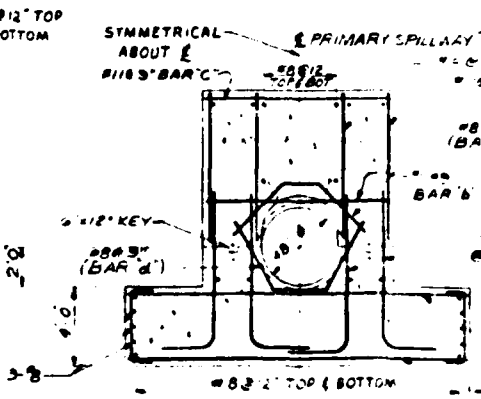
ENLARGED PLAN OF PRIMARY SPILLWAY CAP & VALVE LOCATION

SCALE 1/2"-1'-0"

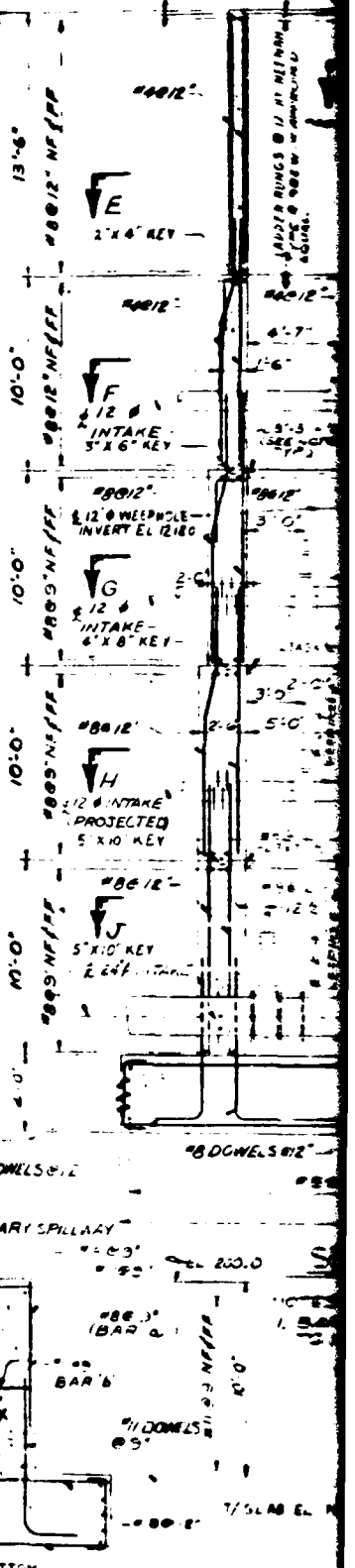


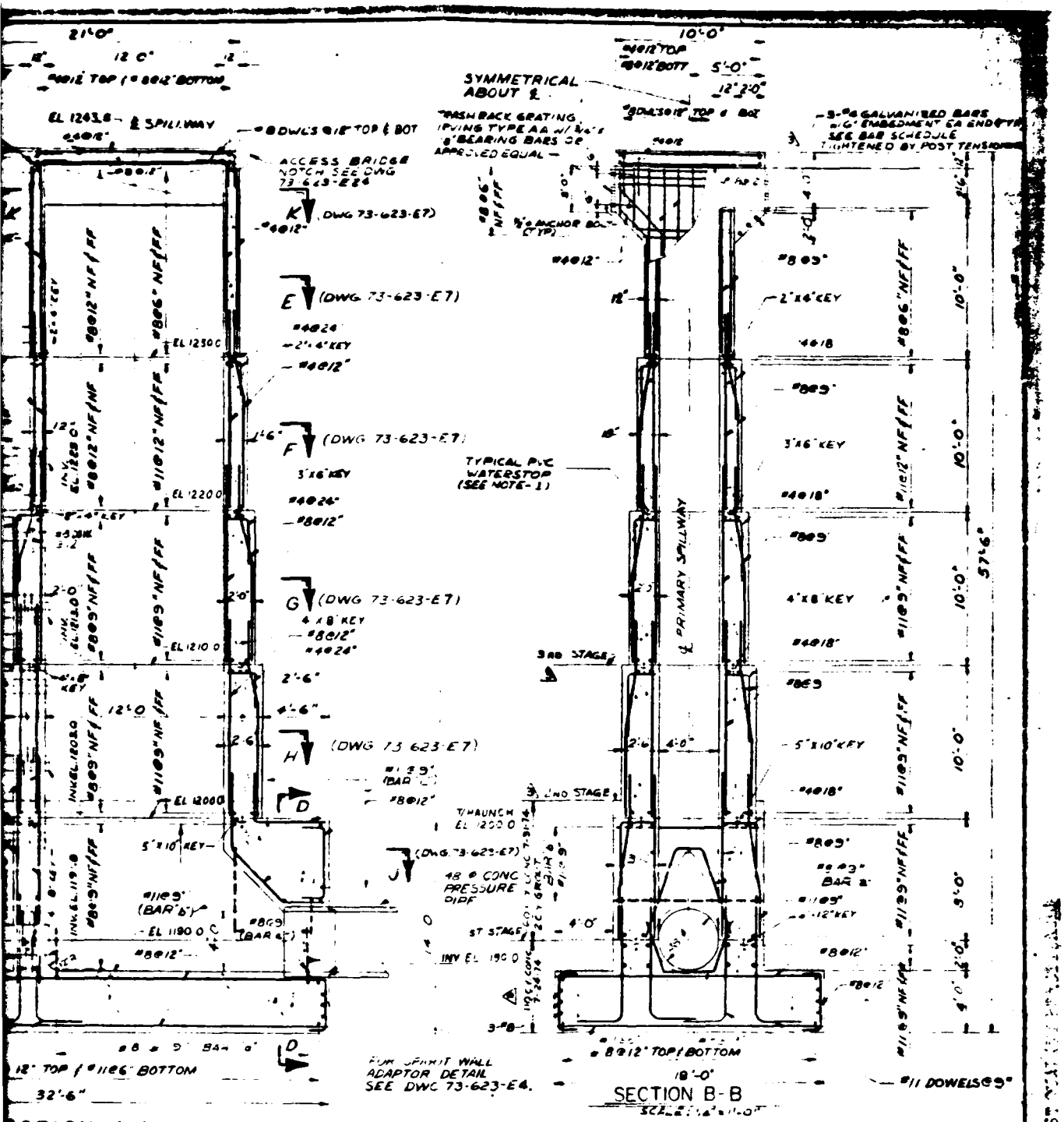
TYPICAL REINFORCING ABOUT INTAKE PIPES AND PIPE SLEEVES

SCALE 1/2"-1'-0"



SECTION D-D



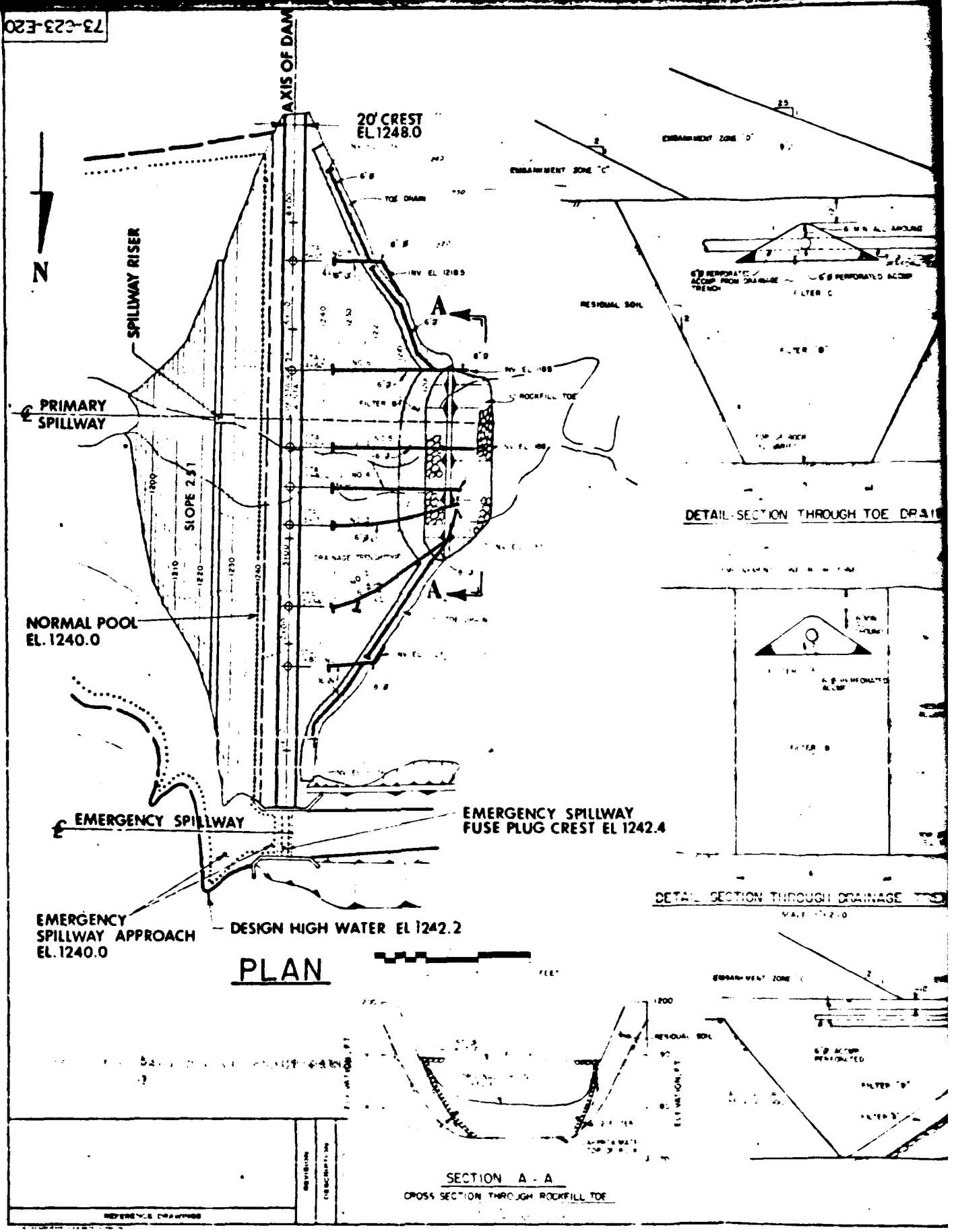


NOTES:

1. FOR KEYS 4'-5 ½" DEEP USE 9" PVC WATERSTOP FOR KEYS SMALLER THAN 4" DEEP USE 6" PVC WATERSTOP.
2. FOR ALL [illegible] DETAILS SEE DWG 73-623-E4.
3. CONCRETE SHALL HAVE A COMPRESSIVE STRENGTH OF 4,000 PSI (f'_c) AT THE END OF 28 DAYS.
4. REINFORCING STEEL SHALL BE GRADE 40 AND CONFORM TO ASTM DESIGNATION A615.
5. ALL REINFORCING DETAILS SHALL COMPLY WITH THE AMERICAN CONCRETE INSTITUTE CODE, ACI 318-71.
6. FOR PLAN & PROFILE SEE DRAWING 73-623-E4.
7. REBAR DESIGNATION a, b, c & d ARE FOR REFERENCE ONLY.
8. FOR INTAKE [illegible] OUT SEE DWG 73-623-E8.
9. FOR FOUNDATION PREPARATION SEE SPECIFICATION.
10. FOR DETAIL OF GRATING & CONNECTION OF L3"x3"x½" TO WALL SEE DWG 73-623-E4.

PLATE 8

ROPPERS COMPANY, INC ORGANIC MATERIALS PLANT PETROLIA, PENNSYLVANIA	
E. D. APPOLONIA CONSULTING ENGINEERS, INC.	
PRIMARY SPILLWAY REINFORCED CONCRETE DETAILS SHEET 6 OF 7	
DRAWN BY: R.F.T. 4-24-74	DRAWING NO. 73-623-E6
CHECKED BY:	


73-623-E20
AXIS OF DAM
20' CREST
EL.1248.0
N
SPILLWAY RISER
PRIMARY
SPILLWAY
SLOPE 2.5:1
NORMAL POOL
EL. 1240.0
EMERGENCY SPILLWAY
EMERGENCY SPILLWAY
FUSE PLUG CREST EL 1242.4
EMERGENCY
SPILLWAY APPROACH
EL.1240.0
DESIGN HIGH WATER EL 1242.2
PLAN
A
A
EMBANKMENT ZONE "C"
RESIDUAL SOIL
ROCKFILL TOE
FILTER C
FILTER B
DETAIL-SECTION THROUGH TOE DRAIN
DETAIL SECTION THROUGH DRAINAGE
SECTION A - A
CROSS SECTION THROUGH ROCKFILL TOE

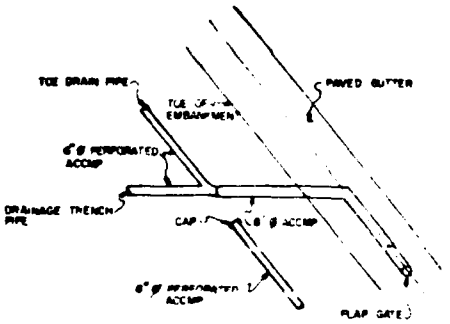
AS BUILT BED ROCK ELEVATIONS

DRAIN NO	PIPE STATION	BED ROCK EL.	BED ROCK TYPE	DRAIN INVERT
1	0+94	1227	SANDSTONE	1226
	0+40	1227	SANDSTONE	1225
2	1+00	1194	SHALE	1193
	2+10	1190	SHALE	1192
3	1+30	1185	SHALE	1194
	1+80	1182	SANDSTONE	1189
4	1+00	1180.5	SANDSTONE	1189.0
	1+80	1178.5	SANDSTONE	1188.5
5	1+30	1181.0	SANDSTONE	1189.0
	1+80	1179.0	SANDSTONE	1188.3
6	1+00	1188.0	SHALE	1198.0
	1+80	1177.0	COAL	1189.0
7	0+94	1211.0	SHALE	1217.0
	1+30	1211.0	SHALE	1216.0

⚠

FLAP GATE

45° ELBOW FOR DISCHARGE TO PAVED GUTTER (SEE DETAIL A)



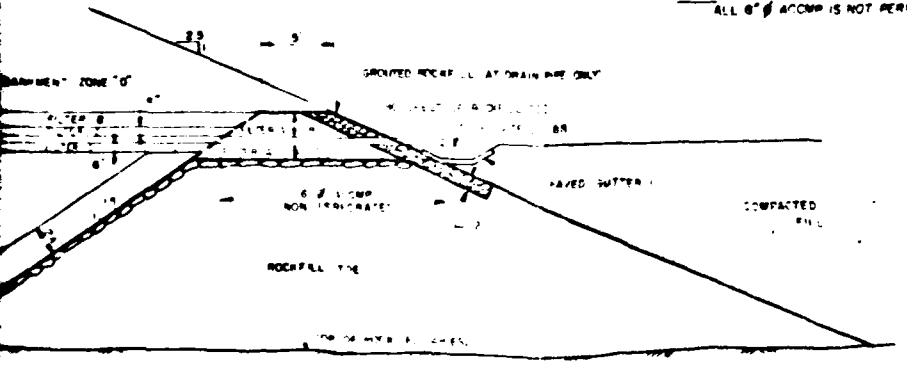
DETAIL "A" PLAN OF DRAIN PIPE DISCHARGE LOCATION

SCALE 1" = 5.0

1 FOR NO 3 AND 6

2 ALL OTHERS DISCHARGE OVER GUTTER IN MANNER SHOWN

NOTE
ALL 6" ϕ ACCMP IS NOT PERFORATED



DETAIL - DRAINPIPE THROUGH ROCKFILL TOE

PLATE 9

KOPPERS COMPANY INC
ORGANIC MATERIALS PLANT
PETROLIA, PENNSYLVANIA

E D'APPOLONIA CONSULTING ENGINEERS, INC

DAM DRAINAGE DETAILS

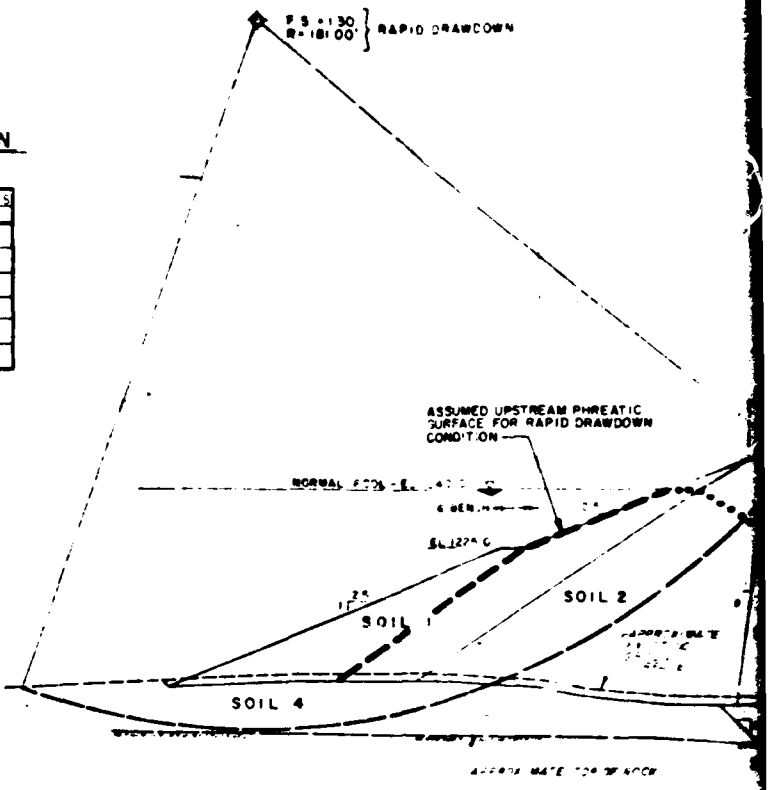
DRAWN BY	J.R.	DATE	DRAWING NO
CHECKED BY		DATE	73-623-E20

⚠ 2

73-623-E18

STEADY STATE SEEPAGE AND RAPID DRAWDOWN SOIL PARAMETERS*

SOIL	TOTAL UNIT WEIGHT γ_t PCF	EFFECTIVE STRESS STRENGTH PARAMETERS c PSF	ϕ DEGREES
1	135	0	34
2	135	0	33
3	130	0	24
4	125	0	30
5	140	10000	40
6	135	-	40



END OF CONSTRUCTION SOIL PARAMETERS*

SOIL	TOTAL UNIT WEIGHT γ_t PCF	EFFECTIVE STRESS STRENGTH PARAMETERS c PSF	ϕ DEGREES
1	135	1270	14.5
2	135	435	19.0
3	130	425	15.5
4	125	425	5.5
5	140	10000	40.0
6	135	0	40.0

*SOIL DESCRIPTION

SOIL 1 WEATHERED SHALE AND/OR SANDSTONE WITH MAXIMUM AVERAGE ROCK SIZE OF 2 INCHES

SOIL 2 WEATHERED SHALE WITH MAXIMUM AVERAGE ROCK SIZE OF 3 INCHES

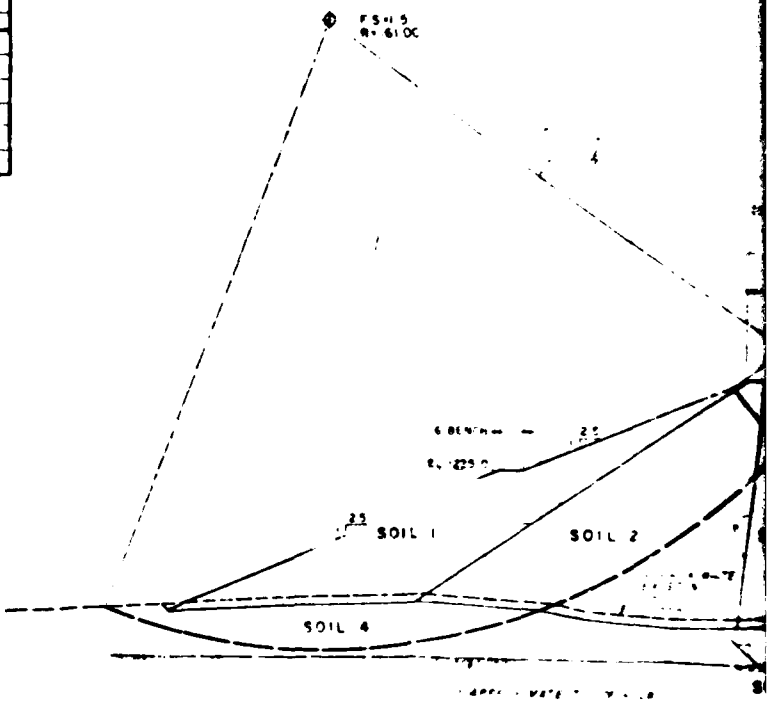
SOIL 3 WEATHERED CLAYSTONE - CORE MATERIAL

SOIL 4 LOOSE TO MEDIUM DENSE SILTY SANDS AND MEDIUM STIFF CLAYS AND SILTS - ALLUVIAL SOIL

SOIL 5 SANDSTONE BEDROCK

SOIL 6 QUARRIED SANDSTONE OR LIMESTONE - ROCK TOE

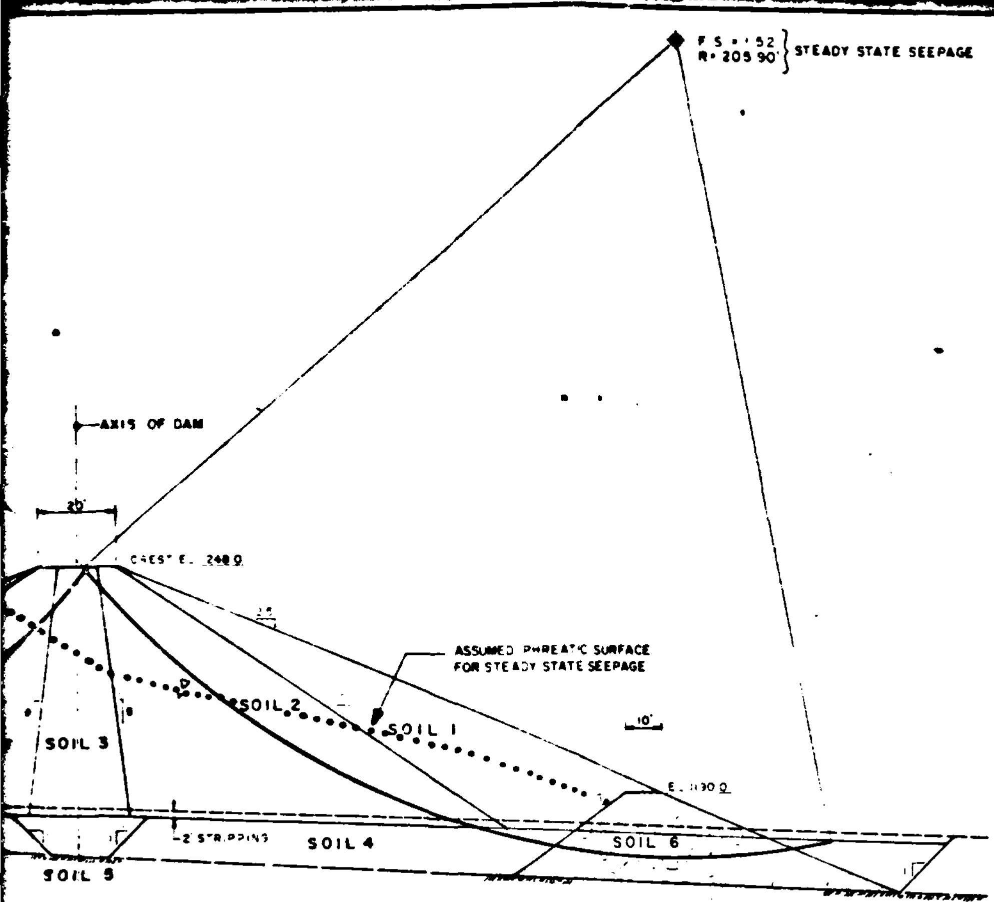
STEADY STATE SEEPAGE AN



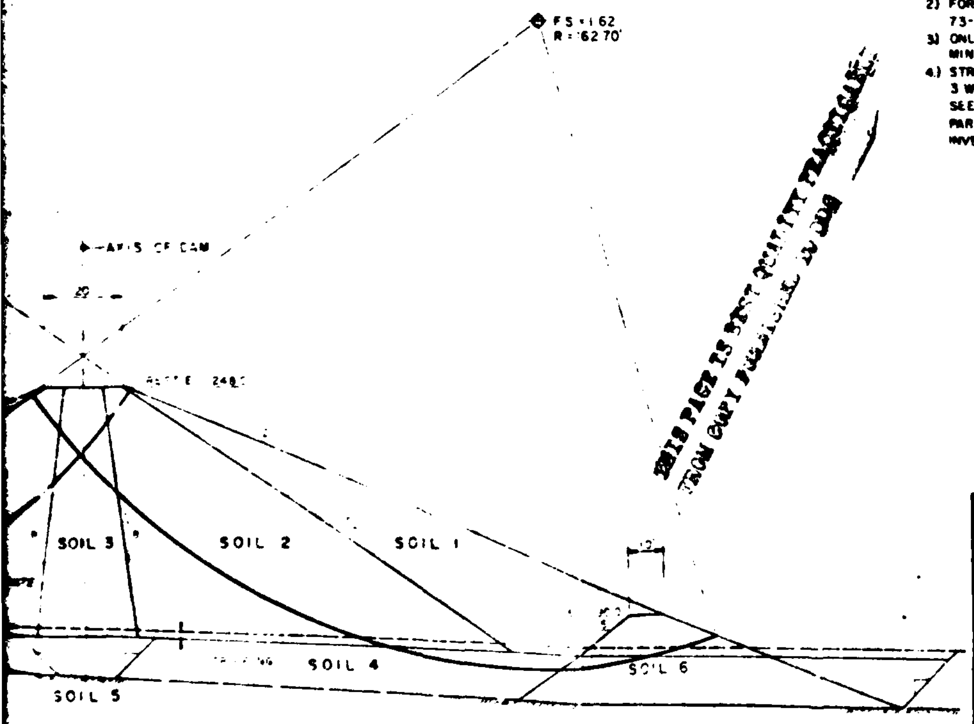
END OF CONSTR

REVISION	DESCRIPTION

REFERENCE DRAWINGS



AND RAPID DRAWDOWN ANALYSES



STRUCTION ANALYSIS

NOTES

1) STABILITY ANALYSES WERE PERFORMED USING A COMPUTERIZED VERSION OF BISHOPS METHOD OF SLICES.
2) FOR PLAN AND LOCATION OF SECTION SEE DWG 73-623-E1
3) ONLY CRITICAL POTENTIAL FAILURE ARCS WITH MINIMUM FACTORS OF SAFETY ARE SHOWN
4) STRENGTH PARAMETERS USED FOR SOILS 1, 2, AND 3 WERE OBTAINED FROM LABORATORY TESTING SEE DWG 73-623-E17 FOR RESULTS. STRENGTH PARAMETERS FOR SOIL 4 WERE BASED ON FIELD INVESTIGATION

PLATE 10

SCALE
0 20 40 60 FEET

KOPPERS COMPANY, INC.
ORGANIC MATERIALS PLANT
PETROLIA, PENNSYLVANIA

E. D'APPOLONIA CONSULTING ENGINEERS, INC.

STABILITY ANALYSES

DRAWING NO
73-623-E18

2

APPENDIX A

CHECK LIST - VISUAL INSPECTION AND FIELD SKETCH

Check List
Visual Inspection
Phase 1

Name of Dam Koppers Petrolia Plant - No. 3 Reservoir Dam. County Butler State PA Coordinates Lat. N 41° 01.3'
NDI # PA 00902
PennDER # 10-74
Long. W 79° 42.7'

Date of Inspection 17 May 1979 Weather Sunny, hot Temperature 80° F.

Pool Elevation at Time of Inspection 1240.0 ft. M.S.L. Tailwater at Time of Inspection 1186.0 ft. M.S.L.

Inspection Personnel:

Michael Baker, Jr., Inc.:

John A. Dziubek
Rodney E. Holderbaum
James G. Ulinski

Site Visit - 19 July 1979

Dr. C. Y. Chen
James G. Ulinski

Owner's Representatives:

Mr. Frank Kurlic

James G. Ulinski Recorder

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS		
DRAINS		
WATER PASSAGES		
FOUNDATION		

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES		
STRUCTURAL CRACKING		
VERTICAL AND HORIZONTAL ALIGNMENT		
MONOLITH JOINTS		
CONSTRUCTION JOINTS		

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM EMBANKMENT
NDI # PA 00902

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Seepage and flow under and along the right downstream abutment drainage gutter is causing erosion and undermining of the gutter. The embankment did not have any apparent sloughing or erosion. The right abutment slope along the emergency spillway channel has a slide. (See Photo 10.) Also, several erosion channels have formed on this hillside.	The slide area should be repaired and the erosion channels riprapped to prevent additional erosion.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Visually, the horizontal alignment is acceptable. Ther vertical alignment was measured by level surveying and found to be above the design top of dam except for the area immediately adjacent to the emergency spillway training wall.	The low area is only 0.2 ft. below the original design top of dam. Restore to original top of dam when practicable.
RIPRAP FAILURES	None observed	

EMBANKMENT

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No problems observed	
ANY NOTICEABLE SEEPAGE	Seepage was exiting from an area at the downstream right abutment contact. (See Field Sketch.) This seepage was flowing from under and around the drainage gutter at an approximate rate of 1 g.p.m. Seepage was also observed exiting the hillside 50 ft. downstream from the dam.	The seepage should be controlled to prevent erosion and undermining of the gutter.
STAFF GAGE AND RECORDER	A staff gage is located on the right side of the riser tower. No recording device was installed.	
DRAINS	The right 8 in. toe drain extending along the drainage gutter was flowing 4 or 5 in. deep at the time of inspection. The last piece of this pipe was disjointed. The animal guard swing gate on toe drain no. 2 was rusted shut.	Repair the pipe and animal guards.

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

OUTLET WORKS
(PRINCIPAL SPILLWAY)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The outlet conduit was in good overall condition. There was some minor seepage through joints. The joint filler has deteriorated at several of the joints.	The joint filler should be replaced, where missing, or repaired, when conditions permit.
INTAKE STRUCTURE	Good condition. Some corrosion of valves and other metal surfaces has occurred.	Corrosion is not harmful at this stage.
OUTLET STRUCTURE	No outlet structure - conduit exits into the grouted riprap-lined plunge pool. No problems observed.	
OUTLET CHANNEL	No serious problems were observed. Some brush was observed at the entrance to the lower reservoir.	
EMERGENCY GATE	The 24 in. drawdown pipe and valve are in good condition.	

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM — UNGATED SPILLWAY (EMERGENCY SPILLWAY)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Some minor cracking of the concrete spillway slab was observed. The fuse plug dike was in place and in good condition. At the time of inspection it was covered with vegetation except for a bare patch on the left side. The level survey indicates that the weir was constructed 0.5 foot higher than the design elevation.	
APPROACH CHANNEL	The approach to the spillway is unobstructed. No problems were observed.	
DISCHARGE CHANNEL	Some debris is located in the discharge channel. A slide located on the right hillside is partially blocking the discharge channel. (See Photos 9 and 10.)	The slide area should be repaired and the debris removed.
BRIDGE AND PIERS	Not Applicable	

GATED SPILLWAY - Not Applicable

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL		
APPROACH CHANNEL		
DISCHARGE CHANNEL		
BRIDGE AND PIERS		
GATES AND OPERATION EQUIPMENT		

INSTRUMENTATION

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	Piezometers were installed to monitor the performance of the dam after construction. During the first visit, "as-built" drawings showing the location of the piezometers were not available. During the site visit, the thick crown vetch made the team unable to locate any of the piezometers.	
OTHER	None	

RESERVOIR

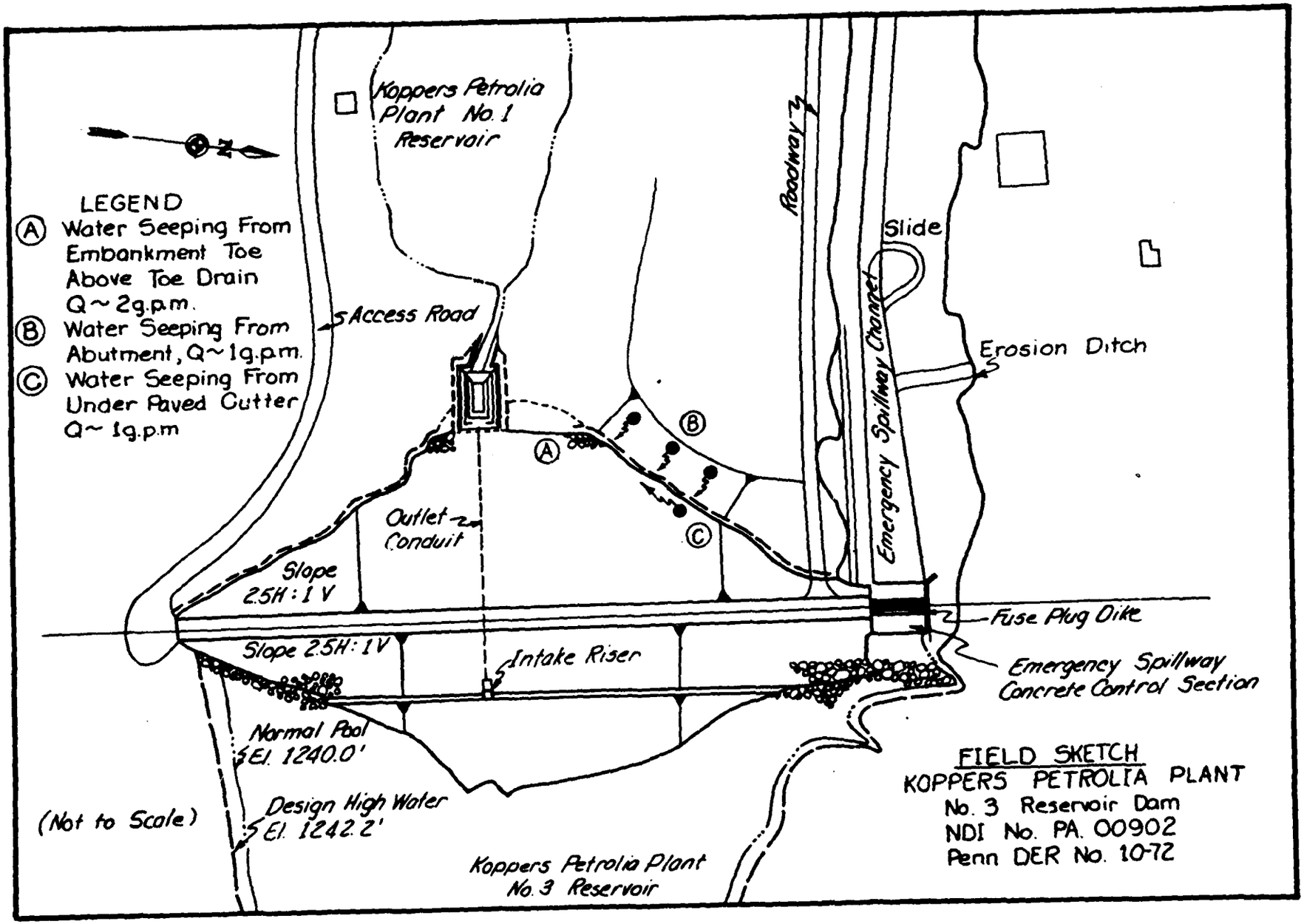
Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The reservoir slopes are relatively steep and primarily wooded or well vegetated.	
SEDIMENTATION	Based on the watershed cover and age of the reservoir, sedimentation should be minimal.	

DOWNSTREAM CHANNEL

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Another dam is located several hundred ft. downstream from Koppers Dam. Discharges through the Koppers Dam emergency spillway exit into the south branch of Bear Creek.	
SLOPES	The slope of the south branch of Bear Creek is mild, averaging approximately 0.2 %.	
APPROXIMATE NO. OF HOMES AND POPULATION	Immediately downstream from the dam is Koppers Petrolia Plant - No. 1 Reservoir and Dam. Below this dam (or approximately 1000 feet below the No. 3 Reservoir Dam) is located the Koppers Plant. An estimated 150 people are employed at the Koppers Plant.	


LEGEND
(A) Water Seeping From Embankment Toe Above Toe Drain Q~2g.p.m.
(B) Water Seeping From Abutment, Q~1g.p.m.
(C) Water Seeping From Under Paved Cutter Q~1g.p.m
Koppers Petrolia Plant No. 1 Reservoir
Roadway
Slide
Emergency Spillway Channel
Access Road
Erosion Ditch
Outlet Conduit
Slope 2.5H:1V
Slope 2.5H:1V
Fuse Plug Dike
Intake Riser
Emergency Spillway Concrete Control Section
Normal Pool El. 1240.0'
Design High Water El. 1242.2'
(Not to Scale)
Koppers Petrolia Plant No. 3 Reservoir
FIELD SKETCH
KOPPERS PETROLIA PLANT
No. 3 Reservoir Dam
NDI No. PA. 00902
Penn DER No. 10-72

APPENDIX B

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

ITEM	REMARKS
PLAN OF DAM	See Plates 3 and 4 of this report. Additionally, a complete set of "as-built" drawings was provided to Michael Baker, Jr., Inc. by the design consultant for use in preparing the Phase I Inspection Report.
REGIONAL VICINITY MAP	See Plate 1 (Location Plan) of this report.
CONSTRUCTION HISTORY	The dam was designed by E. D'Appolonia consulting Engineers of Pittsburgh, PA. The dam was constructed by Ram Construction Co. of Canonsburg, PA from July 1974 to final acceptance in January 1975. However, all concrete work was constructed by the Koppers Co., Inc.
TYPICAL SECTIONS OF DAM	See Plate 5, Typical Sections of Dam.
HYDROLOGIC/HYDRAULIC DATA	Some hydrological/hydraulic data are included in the report, "Hydrology and Hydraulic Calculations." (Available in the PennDER File No. 10-74).
OUTLETS - PLAN and DETAILS	See Plate 6 and 8 of this report.
- CONSTRAINTS	None
- DISCHARGE RATINGS	Available in the PennDER file and included as part of Appendix D.
RAINFALL/RESERVOIR RECORDS	Reservoir records are recorded by the Boilerhouse Superintendent daily. The records are kept for approximately 6 months and then discarded. No rainfull records are kept.

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

ITEM	REMARKS
DESIGN REPORTS	No comprehensive design report was available, however, the construction drawings summarize and present the pertinent information. For example, the boring logs, stability analyses results, and the hydraulic and hydrologic data are presented on the drawings.
GEOLOGY REPORTS	Some information is included in the "Erosion and Sedimentation Control Plan Report," and the "Engineers Report and As-Built Conditions" report.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS	Available in "Hydrology and Hydraulic Calculations" report (available in PennDER File No. 10-74).
DAM STABILITY SEEPAGE STUDIES	Resultant factors of safety, slip circles, strength parameters, and phreatic surface used in the computerized version of Bishop's Method of Slices stability analyses performed are presented on sheet 18 of the design drawings.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	The result of the field and laboratory investigations are presented on sheets 11 through 17 of the design drawings.
POST-CONSTRUCTION SURVEYS OF DAM	No formal post-construction survey of the dam has been performed. During construction, "as-built" information was recorded and is included in the "as-built" drawings for the dam.
BORROW SOURCES	Plate 3 of this report shows the borrow area used during construction and the extent and materials available.

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

ITEM	REMARKS
MONITORING SYSTEMS	Piezometers were installed after construction. See Plate 4 for the proposed locations.
MODIFICATIONS	Maintenance was performed on a leaky valve. No other modifications were performed.
HIGH POOL RECORDS	No formal records are maintained after approximately 6 months.
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None
MAINTENANCE OPERATION RECORDS	No formal records are maintained.

Name of Dam: KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI # PA 00902

ITEM	REMARKS
SPILLWAY PLAN, SECTIONS, and DETAILS	See Plates 3 through 8 of this report. Also see "as-built" drawings.
OPERATING EQUIPMENT PLANS & DETAILS	See "as-built" drawing sheet no. 24.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 0.59 sq. mi. (primarily forest)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1240.0 ft. (181 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1248.0 ft. (278 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: 1246.7 ft.

ELEVATION TOP DAM: 1247.8 ft. (minimum), 1248.0 ft. (design), 1248.2 ft. (average)

CREST: (Emergency Spillway)

a. **Elevation** 1240.5 ft. (concrete slab) 1242.8 ft. (top of fuse plug)
b. **Type** Rectangular concrete structure with erodable fuse plug
c. **Width** 50 ft.; downstream trapezoidal channel: varies
d. **Length** Concrete structure: 45 ft. Fuse plug: 6 ft. Trapezoidal downstream channel: 900 ft.
e. Location Spillover At right end of dam
f. Number and Type of Gates None

OUTLET WORKS: (Principal Spillway)

a. Type Two-way covered riser and 48 in. outlet pipe
b. Location Approximately 415 ft. from right abutment
c. Entrance inverts El. 1240.0 ft. (Riser crest) Intakes: 1225, 1215, 1205, and 1195 ft.
d. Exit inverts El. 1188.0 ft.
e. Emergency draindown facilities 24 in. gated concrete pipe at intake El. 1195.0 ft.

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE Unknown

APPENDIX C

PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View of Dam - Overall View of Dam from Right Hillside

Photo 1 - View of Crest of Dam, Upstream Slope Protection, and Riser

Photo 2 - View of Downstream Slope and Outlet Conduit

Photo 3 - Close-up View of Riser (Note intake control valves located on the upstream portion of the riser.)

Photo 4 - View of Outlet Conduit and Plunge Pool

Photo 5 - Close-up View of Plunge Pool Erosion Protection and Left Hillside

Photo 6 - View of Downstream Reservoir and Koppers Plant

Photo 7 - View of Emergency Spillway Fuse Plug

Photo 8 - View Looking Upstream at Emergency Spillway

Photo 9 - View Looking Downstream at Emergency Spillway Channel

Photo 10 - View of Slide Area on the Right Hillside, Adjacent to the Emergency Spillway Channel

Photo 11 - View of Seepage near the Drainage Gutter on the Right Downstream Slope Abutment Contact

Photo 12 - Close-up of Underdrain Flow and Disjointed Pipe

Photo 13 - View of Downstream Reservoir Spillway

Photo 14 - Overall View of Downstream Reservoir Dam

Note: Photographs were taken on 17 May 1979.

PHOTO 1. View of Crest of Dam, Upstream Slope Protection, and Riser

PHOTO 2. View of Downstream Slope and Outlet Conduit

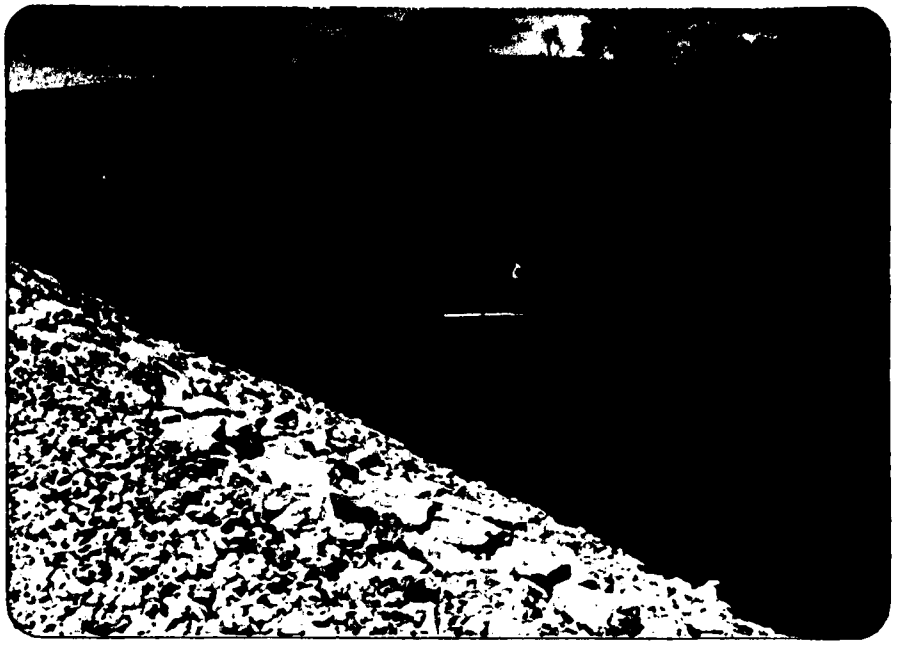


PHOTO 3. Close-up View of Riser
(Note intake control valves located in the upstream portion of the riser.)

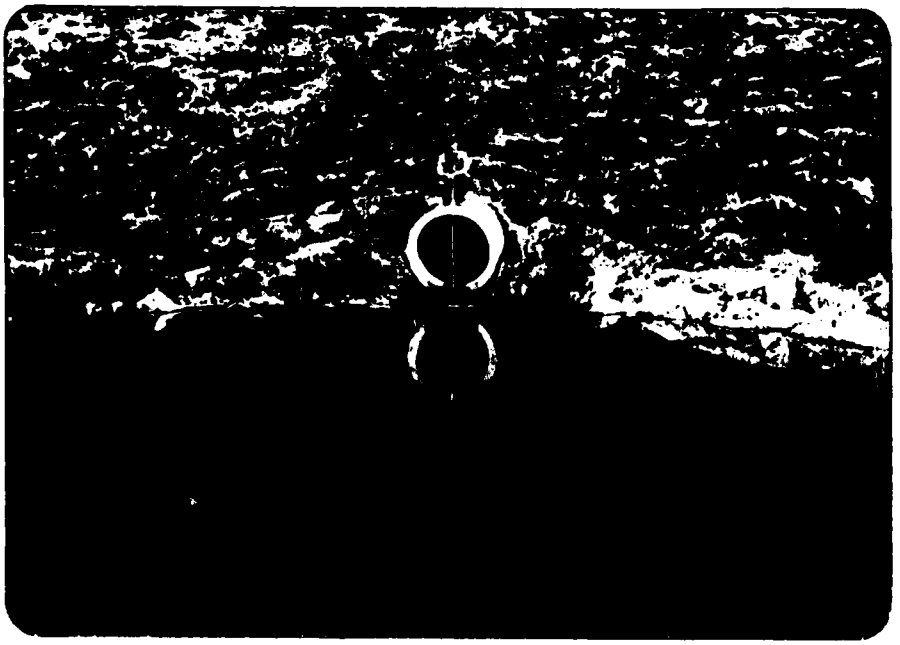


PHOTO 4. View of Outlet Conduit and Plunge Pool

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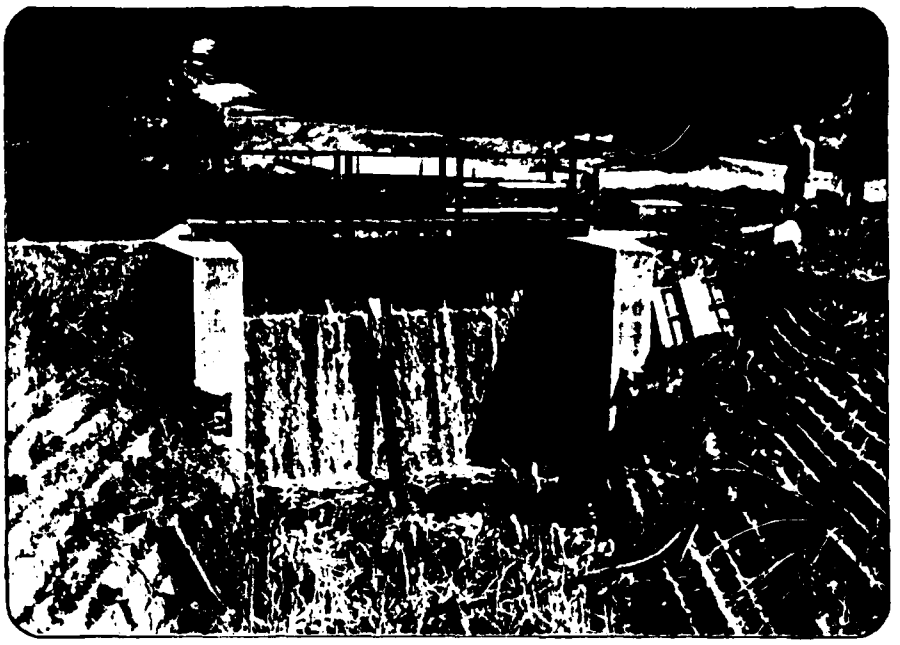


PHOTO 13. View of Downstream Reservoir Spillway

PHOTO 14. Overall View of Downstream Reservoir Dam

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Koppers Dam S.O. No.

Sheet No. of

Drawing No.

Computed by Checked by Date

Table of Contents

PREFACE

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic determinations presented in this Phase I Inspection Report are based on the use of a Snyder's unit hydrograph developed by the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variation of watershed slopes, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed however, a further refinement of these coefficients is beyond the scope of this Phase I Investigation.

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS
Box 280
Beaver, Pa. 15009

Subject KOPPERS DAM S.O. No.
RAINFALL AND HYDROLOGIC DATA Sheet No. 1 of 11
Drawing No.
Computed by G.A.S. Checked by REH Date 3-23-79

RAINFALL (FROM HMR-33)

LOCATED IN ZONE 2

PMP 24 HR. = 200 mi. = 23.75 in.

P 6 HR. = 117% PMP

P 12 HR. = 127% PMP

P 24 HR. = 141% PMP

P 48 HR. = 151% PMP

HYDROLOGIC DATA DRAINAGE AREA LOCATED IN ZONE 24

Ct = PLATE W Cp = 0.45

$t_p = 1.6 (L\,L_{ca})^{0.3}$ t_R = 20 MIN.

L = 0.88 mi. L_{ca} = 0.21 mi. D.A. = 0.59 mi^2

$t_p = 1.6 (L\,L_{ca})^{0.3}$

$t_p = 1.6 (0.88 \times 0.21)^{0.3}$

t_p = 0.96 hr.

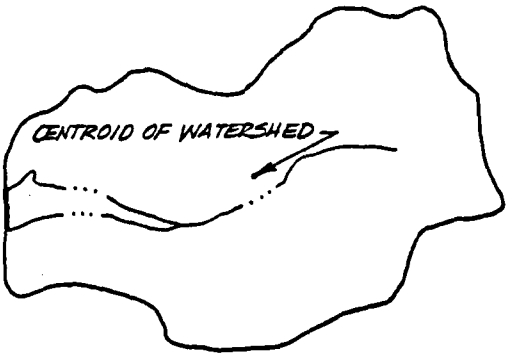
$t_r = t_p / 5.5 = 0.96 / 5.5 = 0.18$ HR. USE t_R = 0.25 HR.

$t_{pR} = t_p + 0.25 (t_R - t_r)$

$t_{pR} = 0.96 + 0.25 (0.25 - 0.18)$

t_{pR} = 0.98 HR

Note: Both L & L_{ca} were measured from upstream end of reservoir to watershed divide.



KOPPERS DAM

DRAINAGE AREA MAP, (0.59 SQ.mi.), L = 0.88 mi. Lca = 0.21 mi.
QUAD : PARKER

2000 0 2000 4000

SCALE IN FEET

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject KOPPERS DAM S.O. No.
STAGE VS. DISCHARGE Sheet No. 3 of 11
Drawing No.
Computed by Checked by Date

PRIMARY SPILLWAY	
STAGE (FEET)	Q (cfs)
1240.0	0
1241.0	11
1242.0	204
1242.8	414
1243.0	415
1244.0	419
1245.0	423
1246.0	427
1247.0	431
1248.0	436
1249.0	*440
1250.0	*445

*EXTRAPOLATED DATA

PRIMARY & EMERGENCY SPILLWAYS	
STAGE (FEET)	Q (cfs)
1240.0	0
1241.0	70
1242.0	200
1242.6	310
1242.8	400
1243.0	870
1244.0	1240
1245.0	1600
1246.0	2050
1247.0	2530
1248.0	3000
1249.0	*3460
1250.0	*3920

*EXTRAPOLATED DATA

SOURCE: DESIGN PLANS FOR KOPPERS DAM

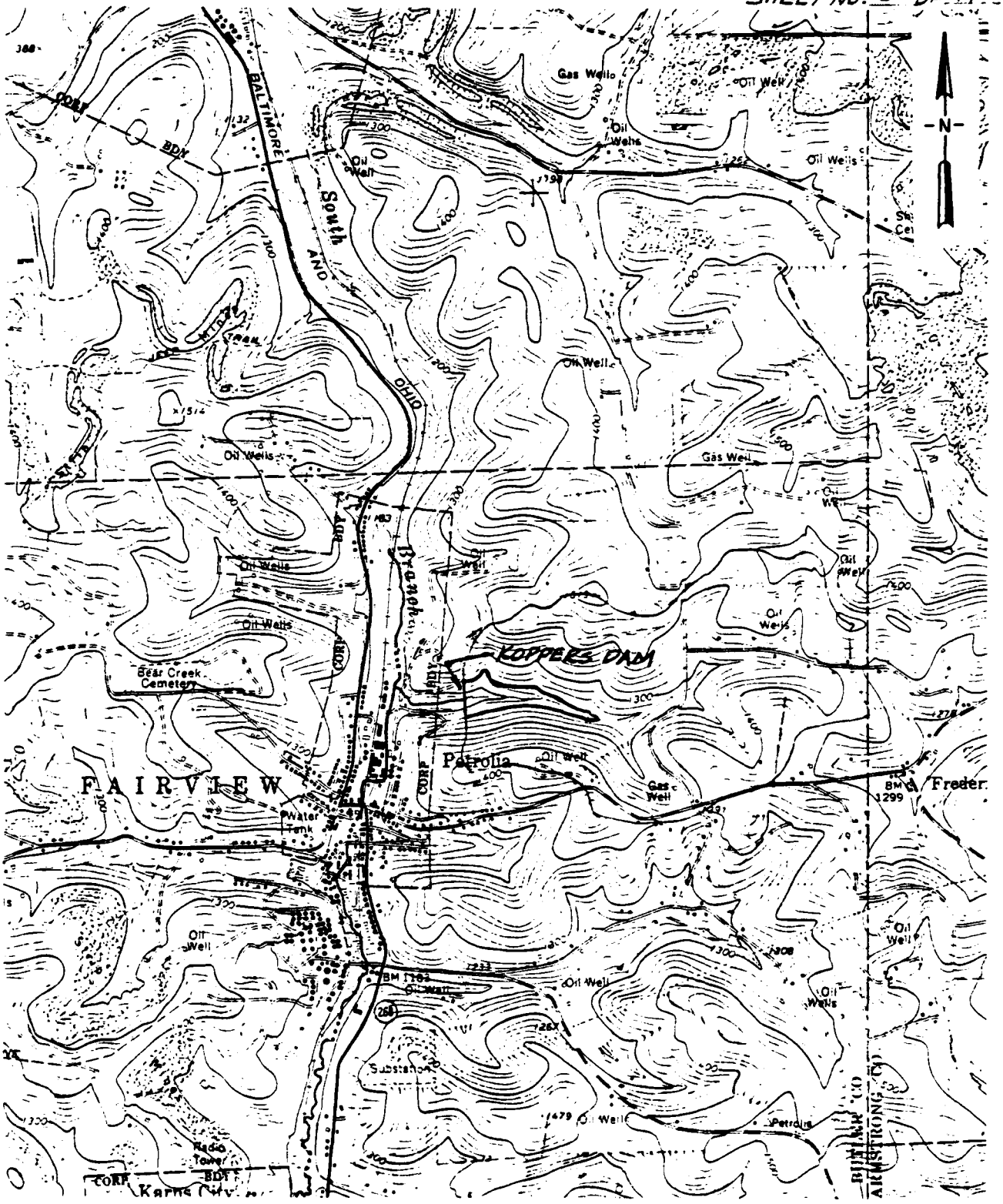
MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject KOPPERS DAM S.O. No.
STAGE VS. STORAGE Sheet No. 4 of 11
Drawing No.
Computed by Checked by Date

STAGE	(Cu. Ft. x 10^6) STORAGE	(A-F) STORAGE
1196.5	0.00	0
1200.0	0.15	3.4
1205.0	0.47	10.8
1210.0	0.85	19.5
1215.0	1.40	32.1
1220.0	2.05	47.1
1225.0	3.00	68.9
1230.0	4.25	97.6
1235.0	5.92	135.9
1240.0	7.90	181.4
1245.0	10.40	238.8
1250.0	13.25	304.2

SOURCE: DESIGN PLANS FOR KOPPERS DAM



KOPPERS DAM

DOWNSTREAM AREA MAP

2000 0 2000 4000

SCALE IN FEET

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
  MBJ UPDATE         04 JUN 79
**********************************
    1              A1       NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
    2              A2       HYDROLOGIC AND HYDRAULIC ANALYSIS OF KUPPERS DAM MBJ  23
    3              A3       PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD
    4              B    200       0      15       0       0       0       0       0      -4       0
    5              B1     5
    6              J      1       1       1
    7              J1     1
    8              K      0       1                                       1
    9              K1       STORM HYDROGRAPH DEVELOPMENT BY SNYDERS UNIT HYDROGRAPH
   10              M      1       1   0.59
   11              P             23.8     117     127     141     151
   12              T                                                     1.0    0.05
   13              M   0.98    0.45
   14              Y   -1.5   -0.05     2.0
   15              K      1       2
   16              K1       FLOOD ROUTING FOR KOPPERS DAM
   17              Y                                      1       1
   18              Y1     1                                              -1240    -1
   19              Y4  1240    1241    1242  1242.6  1242.8    1243    1244    1245    1246    1247
   20              Y4  1248    1249    1250
   21              Y5     0      70     200     310     400     870    1240    1600    2050    2530
   22              Y5  3000    3460    3920
   23              $S     0     3.4    10.8    19.5    32.1    47.1    68.9    97.6   135.9   181.4
   24              $S 238.8   304.2
   25              $E1196.5    1200    1205    1210    1215    1220    1225    1230    1235    1240
   26              $F  1245    1250
   27              $$  1240
   28              $D1248.2    2.65     1.5     660
   29              K     99
```

SHEET 6 OF 11

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
MRJ UPDATE 04 JUN 79
****

RUN DATE 07/17/79
TIME 15.10

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF KOPPERS DAM MRJ 23
PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
200	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0	0		

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= 1.00

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SUB-AREA RUNOFF COMPUTATION

STORM HYDROGRAPH DEVELOPMENT BY SNYDERS UNIT HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	0.59	0.0	0.59	0.0	0.0	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	23.80	117.00	127.00	141.00	151.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.05	0.0	0.0

UNIT HYDROGRAPH DATA
TP= 0.98 CP=0.45 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 35 END-OF-PERIOD ORDINATES, LAG= 0.98 HOURS, CP= 0.45 VOL= 1.00

19.	69.	130.	171.	172.	148.	125.	106.	90.	76.
64.	54.	46.	39.	33.	28.	24.	20.	17.	14.
12.	10.	9.	7.	6.	5.	4.	4.	3.	3.
2.	2.	2.	1.	1.					

SHEET 7 OF 11

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	28.75	26.31	2.44	39851.
										(730.)(668.)(62.)(1128.46)			

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HYDROGRAPH ROUTING

FLOOD ROUTING FOR KOPPERS DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTC
2	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	-1240.	-1

STAGE	1240.00	1241.00	1242.00	1242.60	1242.80	1243.00	1244.00	1245.00	1246.00	1247.00
	1248.00	1249.00	1250.00							
FLOW	0.0	70.00	200.00	310.00	400.00	870.00	1240.00	1600.00	2050.00	2530.00
	3000.00	3460.00	3920.00							
CAPACITY=	0.	3.	11.	20.	32.	47.	69.	98.	136.	181.
	239.	304.								
ELEVATION=	1197.	1200.	1205.	1210.	1215.	1220.	1225.	1230.	1235.	1240.
	1245.	1250.								

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1240.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1248.2	2.6	1.5	660.

PEAK OUTFLOW IS 1863. AT TIME 41.00 HOURS

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SHEET 8 OF 11

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 1.00
				RATIOS APPLIED TO FLOWS
HYDROGRAPH AT	1	0.59	1	1974.
	(	1.53)	(	55.89)(
ROUTED TO	2	0.59	1	1863.
	(	1.53)	(	52.75)(

SHEET 9 OF 11

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	AVERAGE TOP OF DAM
ELEVATION	1240.00	1240.00	1248.20
STORAGE	181.	181.	281.
OUTFLOW	0.	0.	3092.

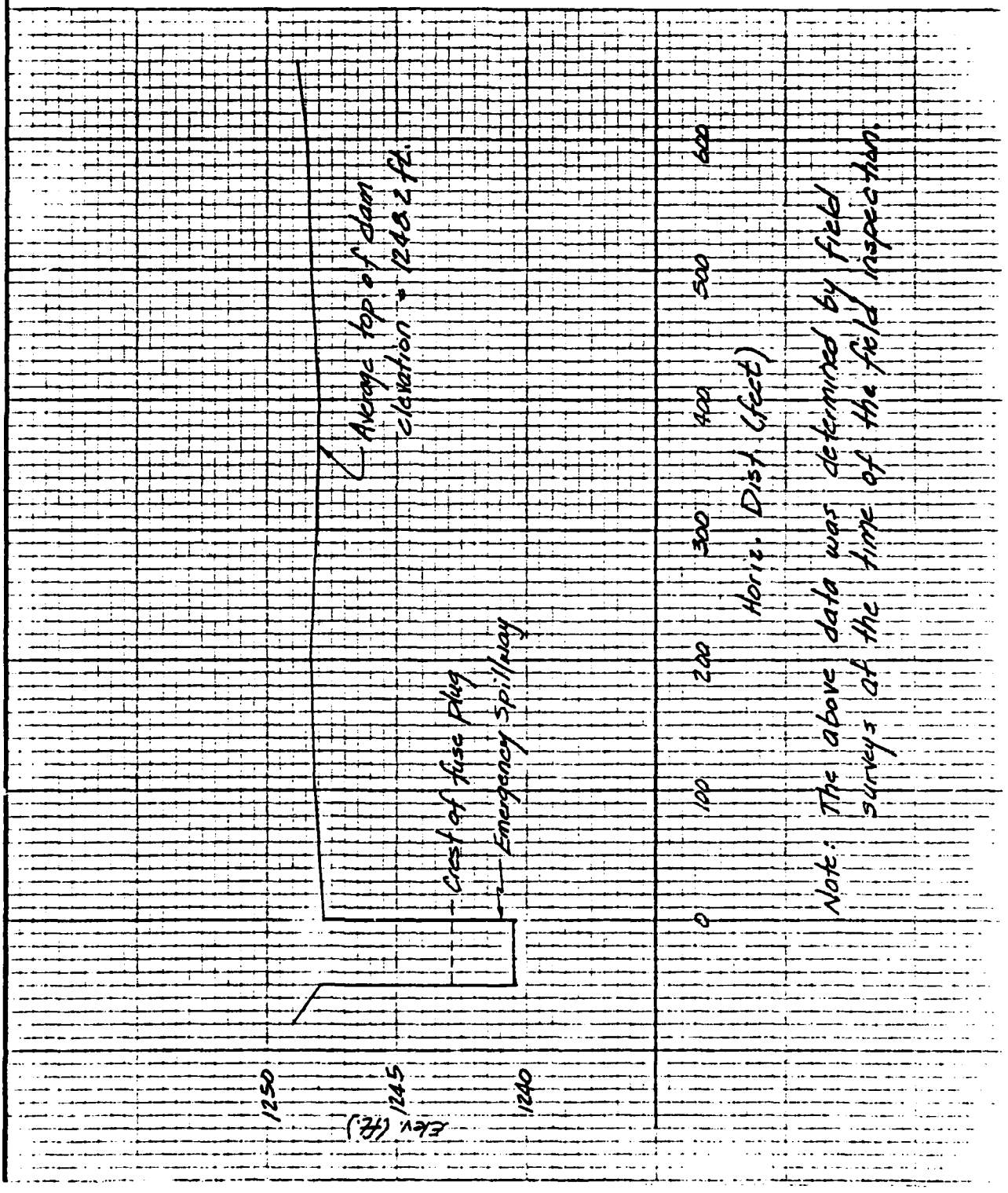
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1245.58	0.0	246.	1863.	0.0	41.00	0.0

SHEET 10 OF 11

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Koppers Dam — S.O. No.
Top of Dam Profile — Sheet No. 11 of 11
Drawing No.
Computed by REH — Checked by — Date 8/15/79



Note: The above data was determined by field survey at the time of the field inspection.

APPENDIX E

REGIONAL GEOLOGY

KOPPERS PETROLIA PLANT - No. 3 RESERVOIR DAM
NDI No. PA 00902, PennDER No. 10-74

REGIONAL GEOLOGY

The dam and reservoir are located in Western Pennsylvania in the section of the Appalachian Plateaus Physiographic Province which has not been subject to glaciation.

Most of the soils beneath the dam are residual sandy and clayey silts between 2 and 10.5 feet thick. The underlying bedrock is primarily sandstone and shale with lesser amounts of coal and claystone; above approximate elevation 1195 feet, the bedrock is predominantly sandstone. These bedrock units are members of the Allegheny Formation, Pennsylvania System. Above approximate elevation 1335 feet, the elevation of the Upper Freeport coal, the bedrock consists of members of the Conemaugh Group, Pennsylvania System. During excavation of the emergency spillway, 2 mine drifts were exposed, one just below normal reservoir pool. These mine drifts were backfilled with clay. Although the name of the seam mined was not given, it appears to be the Lower Freeport.

GEOLOGIC MAP
Koppers Petrolia Plant - No. 3 Reservoir Dam
NDI No. PA 00902 Butler County

Reproduced from Geologic Map of Pennsylvania, Pennsylvania Geological Survey, 4th Series

Scale: One Inch Equals Approximately Four Miles
See Legend, Next Page

PERMIAN

Greene Formation

Cyclic sequences of sandstone, shale, red beds, limestone and coal, base at the top of the Upper Washington Limestone.

PERMIAN AND PENNSYLVANIAN

Washington Formation

Cyclic sequences of sandstone, shale, limestone and coal; some red shale, some mineable coal; base at the top of the Waynesburg Coal.

PENNSYLVANIAN

APPALACHIAN PLATEAU

Monongahela Formation

Cyclic sequences of sandstone, shale, limestone and coal; limestone prominent in northern outcrop areas; shale and sandstone increase southward; commercial coals present; base at the bottom of the Pittsburgh Coal.

Pc

Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections; Brush Creek Limestone in lower part of section.

Allegheny Group

Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestones thicken westward; Vanport Limestone in lower part of section; includes Freeport, Kittanning, and Clarion Formations.

Pottsville Group

Predominantly sandstones and conglomerates with thin shales and coals, some coals mineable locally.

ANTHRACITE REGION

Ppp

Post-Pottsville Formations

Brown or gray sandstones and shales with some conglomerate and numerous mineable coals.

Pottsville Group

Light gray to white, coarse grained sandstones and conglomerates with some mineable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

MISSISSIPPIAN

Mauch Chunk Formation

Red shales with brown to greenish gray flaggy sandstones, includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties, Loyalhanna Limestone at the base in southwestern Pennsylvania.

Pocono Group

Predominantly gray, hard, massive, cross-bedded conglomerate and sandstone with some shale, includes in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Cussewago, Corry, and Knapp Formations, includes part of "Oswayo" of M. L. Fuller in Potter and Tioga counties.